Q
11
N8
1901

University of the State of New York

NEW YORK STATE MUSEUM, Albany

55TH ANNUAL REPORT

OF THE

REGENTS

1901

TRANSMITTED TO THE LEGISLATURE JAN. 2, 1902

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1903

University of the State of New York

REGENTS 1901

With years of election

Administration and geology

Frederick J. H. Merrill Ph.D.	Director and state geologist
Edwin C. Eckel C.E.	Assistant in geology
Frederick C. Paulmier Ph.D.	Assistant in zoology
Herbert P. Whitlock C.E.	Assistant in mineralogy
Joseph Morje	Clerk and stenographer
C. Adelbert Trask	Junior clerk

FIELD ASSISTANTS

In pre-Cambrian geology	Prof. H. P. Cushing, Adelbert College
In Pleistocene geology	Prof. J. B. Woodworth, Harvard University
	Prof. H. L. Fairchild, University of Rochester
In economic geology	Dr Heinrich Ries, Cornell University
In zoology	Dr Tarleton H. Bean
	Prof. James L. Kellogg, Williams College

Paleontology

John M. Clarke M.A. Ph.D.	State paleontologist
Rudolf Ruedemann Ph.D.	Paleontologist's assistant
George B. Simpson	Draftsman
Philip Ast	Lithographer
Jacob Van Deloo	Clerk and stenographer
Martin Sheehy	Helper
D. Dana Luther	Field assistant
H. S. Mattimore	Page and preparator

Botany

Charles H. Peck M.A. State botanist

Entomology

Ephraim Porter Felt D.Sc.	State entomologist
Margaret F. Boynton Ph.B.	Entomologist's assistant
Charles M. Walker B.S.	Entomologist's assistant
George W. V. Spellacy	Page

Archeology

Rev. William M. Beauchamp Author of bulletins

STATE OF NEW YORK

No. 38

IN SENATE

JAN. 2, 1902

55th ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

To the Legislature of the State of New York

I have the honor to submit herewith, pursuant to law, as the 55th annual report of the University on the New York State Museum, the reports of the director of the museum and state geologist, of the paleontologist, of the botanist and of the entomologist, with appendix.

ANSON JUDD UPSON
Chancellor

CONTENTS

New York State Museum

REPORT OF THE DIRECTOR 1901

To the Regents of the University of the State of New York

I have the honor to submit herewith my reports as director of the State Museum and state geologist for the fiscal year ending Sep. 30, 1901.

Respectfully yours

FREDERICK J. H. MERRILL

Albany N. Y. Dec. 31, 1901

GEOLOGY

The work conducted under the direction of the state geologist during the fiscal year just ended may be summarized as follows:

Maps

The office work of the past winter was mainly devoted to the completion for publication of the geologic map of the State on the scale of 5 miles to the inch, which went to the engraver in April and on which considerable time was spent in proofreading during the summer. It is expected that this map will be issued about the first of the new year and a detailed description of it will be given in Museum bulletin 56.

An important contribution to the physical geography of the State is in the form of a hypsometric map on the scale of 12 miles to the inch, compiled under the direction of the state geologist, by Mr C. C. Vermeule, which shows the topography of the State in contour lines 200 feet apart. This map is contained in the pocket of this report and will be found of much use to students of geography and physiography.

The geology of the crystalline rocks of New York and vicinity was replotted on the revised proofs of the Harlem, Brooklyn and Staten Island quadrangles and together with the accompanying text was forwarded to the United States Geological Survey at Washington for publication in the forthcoming New York folio. Duplicates of these maps and of the accompanying text will be issued by the Museum.

Pre-Cambrian and crystalline rocks

Prof. H. P. Cushing of Adelbert College who has been for several seasons engaged in the study of the crystalline rocks of the Adirondacks, during the past year devoted himself to a special study of the area about Little Falls, Herkimer co. As the result of this work, he has mapped the structural geology of the Little Falls quadrangle, which will soon be ready for publication as a bulletin of the State Museum.

The main purpose of the work was the investigation of the pre-Cambrian rocks, but incidentally the Paleozoic rocks were also mapped on the new base.

The pre-Cambrian rocks were found to consist, in considerable part, of garnetiferous, quartz-feldspar gneisses, often holding graphite, which seem clearly of aqueous origin. They are regarded as much altered sandstones and shales belonging to the Grenville series, and are much like rocks described by Professor Kemp from Warren and Washington counties. No crystalline limestone was encountered, though boulders indicate its presence not far outside the map limits.

Aside from these rocks there is much of a variable gneiss which has the composition of a syenite and is regarded as an igneous rock. The Little Falls and Middleville outliers show a porphyritic rock of this sort, whose igneous nature is clear. In other exposures its igneous origin is not so evident. Unfortunately no exposures were found which gave clear evidence concerning its relations to the Grenville rocks. From field evidence elsewhere this syenite is regarded as younger than and intrusive in the Grenville rocks.

The Paleozoic rocks were mapped areally, and their structure and variations in thickness were worked out so far as possible. Decisive evidence of their overlap on the old land surface of the pre-Cambrian rocks was found. Attention was also given to the glacial deposits and to the reasons for the present topography.

There are no rocks or mineral deposits of great economic value in the region. There are good building stones for some local uses, abundant road metal and a little iron ore. There may also be good brick clays, though this is not certain.

A short visit was also made to the Tupper lake region for the purpose of taking photographs and of examining rock outcrops exposed during road construction and soon covered by the filling of road material. The exposures were of augite syenite throughout.

Mr E. C. Eckel, assistant in geology, spent most of the month of October and part of November 1900 in Orange county, N. Y., in a reconnaissance of the pre-Cambrian rocks. The boundary between the pre-Cambrian and the Paleozoic formations was

mapped in the region from Newburg southwest to Monroe, and some of the Paleozoic boundaries were retraced on the newly issued topographic atlas sheet covering that region. Several outcrops of crystalline limestone, occurring in the Highlands between Central Valley and Fort Montgomery, were critically examined, and it was decided that, in place of the pre-Cambrian age usually assigned to them, they were probably Paleozoic, being underlain by a quartzite corresponding to the Cambrian quartzite of Dutchess, Putnam and Westchester counties. Late in November, field work in the northwestern part of Putnam county confirmed these views, similar highly crystalline limestone being found in similar association with quartzite.

During the greater part of the winter and spring, Mr Eckel was employed in cooperation with a draftsman on the compilation and drafting of the new edition of the geologic map of the State. Several short trips were made by him in April, May and June for the purpose of verifying previous work in the western part of the State.

During the remainder of the fiscal year he was employed in work on the metamorphic rocks of southeastern New York and western Connecticut, part of this time being spent with the state geologist in the field conference mentioned below.

In September a field conference was held by the state geologist with Professor Van Hise of the United States Geological Survey, which extended from New York city and Westchester county, N. Y., into western Connecticut and northwestern Massachusetts. The consequence of this conference was that the work in the region about New York city, which had been carried on by the writer for many years, and of which the results are to be published in cooperation with the United States Geological Survey, was found to be entirely correct. The New York classification is accepted and will be extended into Connecticut and Massachusetts. One technical question raised by Professor Van Hise could not be decided in New York, and in consequence it seemed necessary for Mr Eckel to make some visits to southwestern Connecticut in search of further evidence. The ob-

servations made by him there have resulted in the complete confirmation of the views which I had previously expressed.

These facts are of interest in that they give New York, in the study of the crystalline rocks of its southeastern portion, the distinction of having its classification accepted for those adjacent areas in which these rocks occur, this distinction having previously been attained by the early corps of New York geologists and their successor, Professor Hall, in the classification of the Paleozoic rocks of New York.

Pleistocene

Hudson-Champlain valleys

During the field season of 1901, Professor Woodworth continued the investigation of the nature and extent of the submergence of the Hudson and Champlain valleys during and immediately after the disappearance of the Wisconsin ice sheet.

In April a week was spent in examining certain localities about the mouth of the Hudson, in Westchester county, on Long Island, and in the neighboring low ground of New Jersey. About the middle of June, he took to the field in the upper Hudson valley and spent nearly a month in tracing out the Pleistocene deposits on the Saratoga and Schuylerville quadrangles so far as they promised to afford a clue to water levels, thus filling out his knowledge of an area not visited in the previous year. He was given leave of absence from the field during midsummer, and in the middle of August returned to the shores of Lake Champlain to resume the work begun there in the previous summer. He was occupied in this field in going over the area covered by the topographic folios south of Plattsburg till called to Cambridge by his duties in Harvard University.

The more important results of this field work are as follows:

There exists along the coast of Monmouth county, N. J., just outside of the terminal moraine and its attendant outwash plain a terrace whose altitude is about 40 feet above the present sea level, but whose outer border has been cut back by wave action, and whose surface, as for example in the valley of

Cheesequake creek, has been deeply excavated. The presumption is strong that this terrace was produced at sea level when the land was relatively lower than now. The valley of Cheesequake creek, a broad, open marsh-filled depression, appears from its steep sides to have its bottom below the present sea level, pointing to a time of a higher stand of the land following the epoch of terrace-making on that coast. No trace of this terrace has been detected by Professor Woodworth along the coast of Staten and Long islands. The reason for this is believed to be that the Monmouth terrace just outside of the ice-covered district was made before the southernmost glacial deposits of the last ice advance were laid down, so that any traces of such a terrace which may have been developed over the seaward face of the lands in the area of Long and Staten islands were effaced by the latest glacial deposits if not by earlier glacial drift and ice action. The depressions excavated by streams in this extraglacial terrace also indicate a greater antiquity than the latest glacial deposits in the vicinity of New York, none of them bearing signs of so marked a degree of dissection by small streams. It, therefore, seems conclusive that the epoch of depression marked by the terrace south of the Raritan in New Jersey antedates the disappearance of the ice sheet and hence has no relation to the later epoch of depression in the St Lawrence valley, commonly known as the Champlain epoch of submergence.

Inside the moraine, evidence of a water level from 35 to 40 feet above the present sea level, first noted on Long island was found to exist also near Perth Amboy in a small sand delta built in the presence of the ice. Farther north at Englewood N. J. a plain at somewhat lower level indicates a probable water body at about 20 feet above present sea level. These sand plains are of particular interest, as their indexes of level are positive, fixing approximately the depth of water. Their situation inside the moraine, however, in the presence of the melting, presumably irregular, ice front is not conclusive evidence of submergence beneath sea level, since the moraine at the Narrows may have at the time been unbroken, and the

irregularities of the ice may have been such as to make temporary lakes along the ice front between the ice and the moraine. The failure of anything like wave action on the sea-exposed side of the moraine at Staten island at the 35 to 40 foot level is presumptive evidence that the water body existed only on the north side and thus favors the temporary lake view. The decided falling off in level of these sand plains stage by stage from Perth Amboy to Englewood and next at Tappan in New York indicates either a progressive rise of the land as the ice retreated or a lowering of impounded water by the down cutting of the morainal barrier and the melting of outlying ice masses in the present kills communicating across the moraine.

A further examination of the sand pits near Roslyn on Long island disclosed in the till bed beneath the moraine certain glacially transported boulders which appear without doubt to have journeyed from the Adirondacks. These fragments so far as now known afford the evidence of longest transportation in the eastern part of the State.

An examination was also made of certain fine silty deposits in the Bronx and within the built up district of New York city to determine their origin and if possible the time of their deposition. While their subaqueous deposition must be admitted as possible, it seemed to Professor Woodworth, from the character of their topography and the occasional scattering over their surface of glacial erratics, that these deposits belong to a time prior to the retreat of the glacier and thus are not to be correlated with the so called Champlain depression which followed the disappearance of the ice.

In the area of the Schuylerville and Saratoga atlas sheets numerous facts were obtained concerning the altitude of the Albany clays, the deltas of streams and the position of the melting ice sheet and its minor moraines, all of which observations served to make more definite the history of the ice retreat and thus the knowledge of the extent of open country covered by water during the deposition of the clays. It was ascertained for instance that the Adirondack portion of the Hudson

quite early in the disappearance of the ice about the southern flanks of the Adirondacks discharged at Corinth southward toward Saratoga, being prevented from an eastward discharge by the ice on the southeast base of the mountains, and that with the retreat of the ice from Palmertown mountain the Hudson escaped from the gorge at that mountain and, turning abruptly southward, spread out a sandy delta in the region of Gansevoort. This delta is now largely an area of shifting sand dunes like that of the ancient Mohawk delta between Albany and Schenectady. Later, with the melting out of the ice over the Fort Edward plains, the river fell into its existing channel, first building another sand delta at the eastern base of Palmertown mountain, forming the sand tract south of Glens Falls. Thus the Adirondack-Hudson has three large glacial deltas built in successive stages of the disappearance of ice barriers about the southeast versant of the Adirondacks and before the melting out of the glacier from Lake Champlain; hence all of them, unless it be the last named, are older than the Champlain marine deposits. Further examination of the region about Fort Edward and Schuylerville served to show that the upper Albany clays are interrupted in their northward extension between these two places, and that the low lying clays about the former place had been advanced on by the ice while the higher lying clays to the south had not. As the higher clays extend northward to the line where signs of overriding ice appear, it is inferred that the ice formed a barrier on the north to the deposition of the higher clays which extend southward to Albany and beyond. A corollary of this conclusion is that the so called Albany clays are somewhat earlier in age than the typical marine clays of the Champlain valley, which could not have been deposited before the ice sheet had melted out of that valley.

These observations agree perfectly with the history of the development of glacial deposits in the longer known glacial districts on the east and west, in which it has been shown that the late Pleistocene deposits occur in stages, earlier on the south

and later on the north, with here and there clays of marine or lacustrine origin sheeting over the glacial deposits.

The work in the Champlain valley was wholly conducted on the New York State side and directed to the fixing of the upper limit of wave action and of the clays. An important deposit with an upper wave limit of 520 feet was discovered near Street Road, which by comparison with the highest definite beach between Port Kent and Keeseville served to give a base of reference for the deformation of the highest wave line. While the strength of wave action at this high level (590 feet near Port Kent) is consonant with the theory of submergence to this depth at that point, the evidence which would serve to discriminate between marine and lacustrine wave action was not locally determined. The tilting of this upper level in the Champlain district is at the rate of nearly 2 feet to the mile. From a comparison of these northern stations with the elevations of deltas south of Whitehall, it appears that there is a marked sag about the southeastern base of the Adirondacks.

Owing to enforced absence from the field for about a month during the middle of the summer and his return to Cambridge early in the autumn, Professor Woodworth did not find it possible to cover the area north and west of Plattsburg, in which it is expected that critical evidence will be found on which to distinguish the marine and nonmarine beaches of this district and thus determine definitely the hight of true marine submergence in this field.

On account of the complexity of Professor Woodworth's subject and the very extensive field which he has to cover it is not possible for him to make an extended report of progress till further work has been done. It is expected that another field season will put him in a position to make a communication of much interest on the subject of his investigations.

Incidently as pertinent to the work of the State Museum, he reports the discovery of a small mass of trap rock heretofore unrecorded on the geologic map near Schuylerville. This trap exists in an amount above water level sufficient to afford some

supply of excellent road metal for the vicinity. Some of the scientific aspects of this rock, which appears to be of volcanic origin, have been described for publication in this report with suitable illustrations.

He also notes the occurrence of sand-blasted pebbles on an ancient wind-swept delta of the Saranac near Morrisonville, specimens of which have been deposited in the museum. He also sent to the museum the chance find of a crushed Indian skull discovered in the bank on the lake shore of the sand flats between Fort Ticonderoga and the ferry landing.

Central and Western New York

Prof. H. L. Fairchild of the University of Rochester has continued his work of the previous year in the study of glacial phenomena in central and western New York.

A belt of moraines lying east of Irondequoit valley was mapped for a few miles. These moraines are significant as probably correlating with the Pinnacle hills (Rochester-Albion moraine), and the study will be continued as opportunity is found.

In July a few days were spent in the region of Oneida-Rome in reviewing the work of the previous summer and in extension of the study. A few of the observations have been added to the text and maps of the former report which is now in press. Between Oneida and Rome a series of stream channels were studied. These were formed by the eastward flow of waters just previous to the establishment of Lake Iroquois. The New York Central Railroad lies in these channels. They were evidently formed at the glacier front, since their north banks are usually lacking.

The principal work of the summer was in the Lake Erie basin. The ancient beaches parallel with the south shore of the present lake were carefully mapped. In a general way these beaches have been traced by Frank Leverett, G. K. Gilbert and F. B. Taylor, but no detailed maps or descriptions have been published. The gravel and sand bars were located on the topographic sheets from a point southwest of Ripley, near the State

line, northeastward through the "grape belt" of Westfield, Portland, Brocton and Fredonia, past Forestville and Silver Creek to Cattaraugus creek, a distance of 40 miles. Throughout this extent there are two well marked water levels, about 70 feet apart. The higher is the extension of the "Belmore" beach, which was made by the waters of Lake Whittlesey. The lower is the "Forest" beach, produced by Lake Warren. Above the "Forest" bars from 10 to 25 feet is a continuous series of strong bars which represent the "Arkona" beach, now regarded as an earlier and higher level of Lake Warren.

During another season's work, it is proposed to reexamine some sections of the beaches and to extend the survey northeastward through Erie county to the end of the series. Part of this work has already been done. Mr Frank Leverett has shown that the higher beaches disappear in Erie county, and only the lower or Warren shore line continues. Professor Fairchild traced this lower shore line eastward from Crittenden to the meridian of Rochester several years ago.

Attention being concentrated on the mapping of the strong and closely associated shore lines, but little search was made for the beaches of the predicated Lake Dana, about 180 feet lower than the Warren, but some detached bars strengthen the expectation of finding this water level in the Erie basin.

For the accurate mapping of these several beaches, it is desirable to have the topographic sheets of the quadrangles immediately south and east of the Buffalo quadrangle. Indeed the entire row of sheets on the parallel of Buffalo are needed for the full investigation of the glacial lake history. As the study of ancient lake phenomena makes so large use of land altitudes, the topographic sheets are specially requisite. But the topographers should have sufficient knowledge of the genesis of land forms to prevent their running contour lines up and down across conspicuous horizontal beaches, as in the present sheets.

Economic geology

In economic geology Dr Heinrich Ries of Cornell University has been occupied with the study of the peat and marl deposits

of the State, and has prepared a paper on these subjects, which is included in the present report. The growing interest in this country in the uses of peat makes this investigation a matter of general importance and it seems probable that as soon as sufficient capital has been invested to make practical tests of the methods of utilizing this material, it will become more extensively a matter of commercial importance.

This review of the peat industries and the occurrence of the material in New York State is only preliminary and further field work is being carried on for the preparation of an extended report, giving descriptions of the various important deposits of peat which occur within the limits of the State.

A report on the lime and cement industries of New York by the same author, to which Mr Edwin C. Eckel has contributed several chapters, is now in type and will soon be issued as Museum bulletin 44. A short paper on the geology of molding sand is contributed to this report by Mr Eckel.

The chief work of the office in economic geology has been the preparation of an exhibit of the mineral resources of the State for the Pan-American Exposition. This exhibit was made up with the help of an appropriation of about $9000 from the state board of managers, and at the close of the exposition will be installed in Geological Hall. In the progress of the work, statistics, which will form the subject of a report on mineral products, have been obtained from all the mineral producers in the State.

During the year a large number of letters were received, requesting information in regard to the geologic structure of portions of the State, or making inquiries about the value of specimens of various mineral products. Many inquiries were also received from manufacturers located outside the State, requesting aid in obtaining supplies of certain mineral products, or in locating new industries based on our mineral resources.

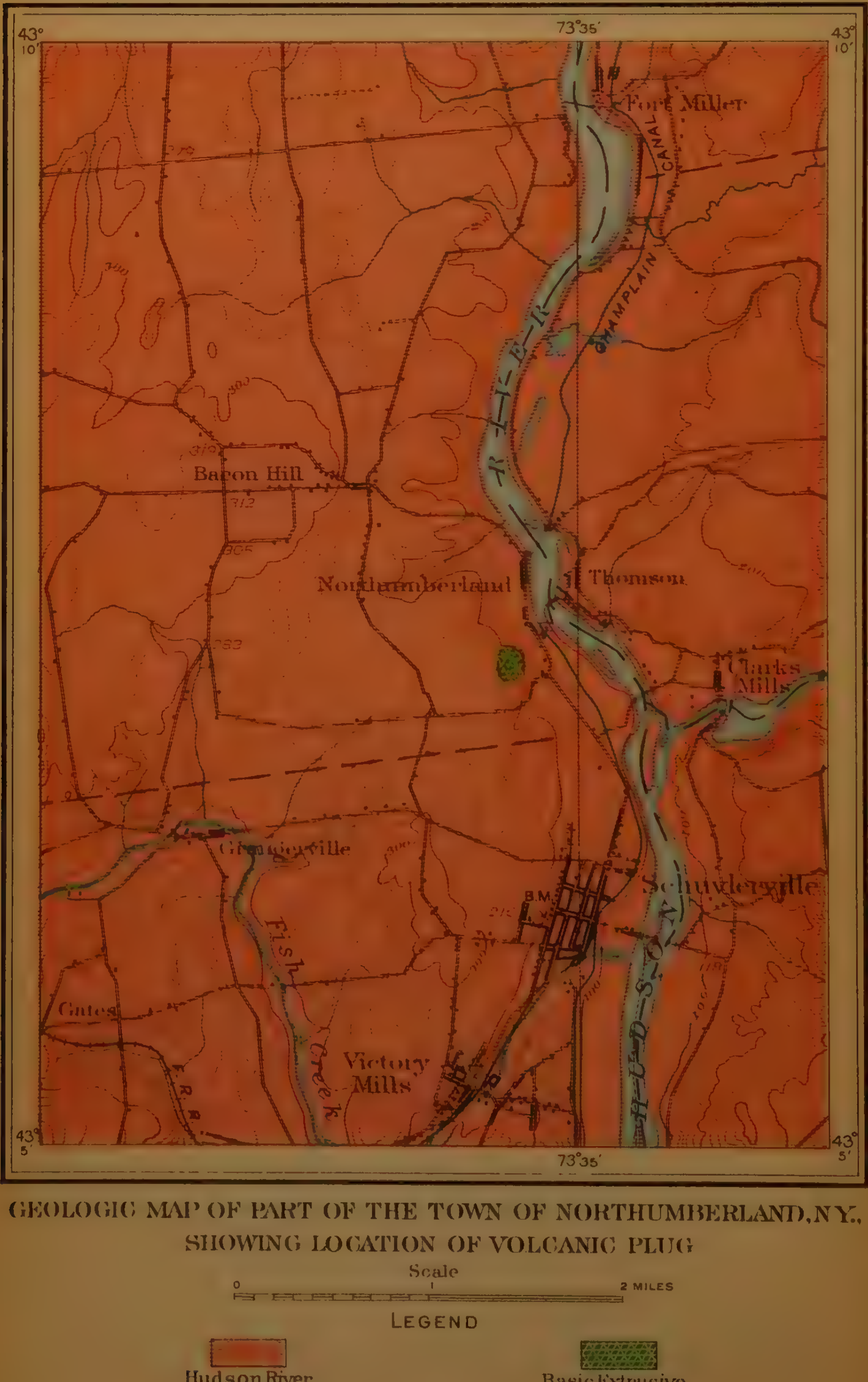
These letters as in former years were answered promptly and as fully as possible.

UNIVERSITY OF THE STATE OF NEW YORK
NEW YORK STATE MUSEUM

PLATE 2

FREDERICK J H MERRILL
DIRECTOR & STATE GEOLOGIST

21ST REPORT OF STATE GEOLOGIST
55TH REPORT OF STATE MUSEUM



GEOLOGIC MAP OF PART OF THE TOWN OF NORTHUMBERLAND, N.Y.,
SHOWING LOCATION OF VOLCANIC PLUG

Plate 3

H. P. Whitlock, photo.

VOLCANIC NECK, SCHUYLERVILLE, SARATOGA CO.
General contour from the north

THE NORTHUMBERLAND VOLCANIC PLUG

BY J. B. WOODWORTH

In the summer of 1901, the writer, in making a reconnaissance of the Pleistocene deposits of the Hudson valley in the vicinity of Schuylerville, came on an undescribed occurrence of igneous rock in the form of a low knob in the town of Northumberland. The accompanying map, plate 2, shows the position of this small knob, about 1 mile north of the village of Schuylerville, on the west bank of the Hudson river.

The right bank of the Hudson river here consists of the usual bluff of Hudson river slates partly masked by Pleistocene clays. The igneous rock, being more resistant to erosion than the fragile slates, has withstood better the glacial erosion to which the region has been subjected and therefore stands out as a sort of buttress from the main wall of the inner Hudson valley or gorge. Much like the volcanic necks and plugs about Edinburgh in Scotland, this hard mass has been deeply scoured at base on the ice-struck side. In fact, all of the present relief of this plug and the adjacent river valley is due to the action of the river combined with that of the ice sheet of the glacial period.

The summit of the knob scarcely attains the level of the upland which lies west of the river. A slight depression west of the plug serves to give it the appearance of a low knob (pl. 3) when viewed from the upland, but at a distance it is relatively inconspicuous. This fact, taken in connection with the dark color of the rock in which respect it closely resembles the adjacent Hudson series, perhaps accounts for its going so long unnoticed or at least undescribed by the geologists who have passed through the upper Hudson valley. There is no mention of the knob by Peter Kalm or later observers; yet it appears from Brandon's[1] historical map of Old Saratoga that General Stark of the American army occupied the eastern base of this knob during the battle of Saratoga. Until the knob shall have been dug away for road metal, it seems not inappropriate to designate it as Stark's Knob, and that name will be used in this paper for convenience of reference.

[1] Brandon, *Rev.* John Henry. Story of Old Saratoga. Albany 1900.

Geologic relations of Stark's Knob

Stark's Knob igneous mass lies surrounded on the ground by the Hudson river slates. The accompanying sketch map, figure 1, exhibits the essential features of the geologic relations. The Hudson slates are highly inclined, cleaved, and much broken rocks. A general northeast and southwest strike of the beds

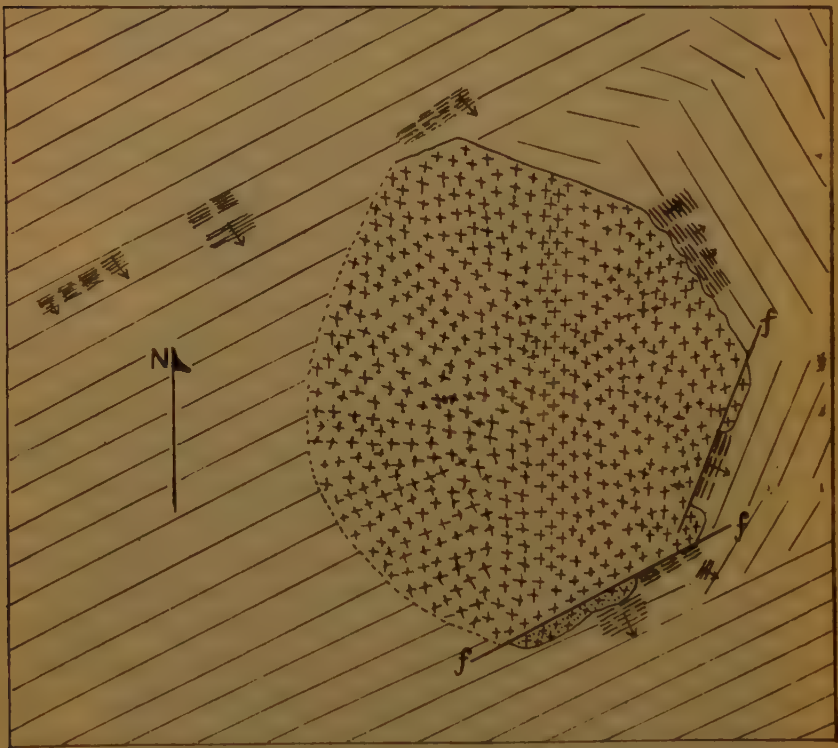


Fig. 1 Ground plan of Stark's Knob plug, showing boundaries as they appear when traced on the present surface, with two faults, fff. The close set, parallel lines show the position of outcrops of the Hudson river slates, the arrows the direction of dip; the wide set lines exhibit the average strike of the slates in the vicinity.

is observed in this district, but in the vicinity of Stark's Knob this direction is departed from on the east quite down to the river road. So far as my own observations go, there are no small dikes radiating from the main igneous mass into the adjacent cleaved sedimentary rocks, nor are there any noticeable signs of metamorphism in these rocks attributable to the heating action of the lavas in the plug. The Hudson river group

Plate 4

H. P. Whitlock, photo.

VOLCANIC NECK, SCHUYLERVILLE, SARATOGA CO.

View from the south showing slate in front of the diabase and south of fault

throughout this region is somewhat altered, but not more so at Stark's Knob than remote from it. In the road on the southeast of the knob, veins of calcite fill cavities of dislocation in the slates and are probably to be referred to solfataric action attendant on the irruption of the igneous rock in the neighboring knob. This lack of contact metamorphism, unless such alteration be limited to baking, which was not observed in the accessible portion of the contact, and the failure of apophyses or branching dikes are points of little value in determining the origin of the igneous rock in the knob. It remains to determine by other evidences whether the rock is intrusive or extrusive.

On the southeast side of the igneous mass and dissecting its border are two faults; that on the eastern side strikes n. 9° e.,

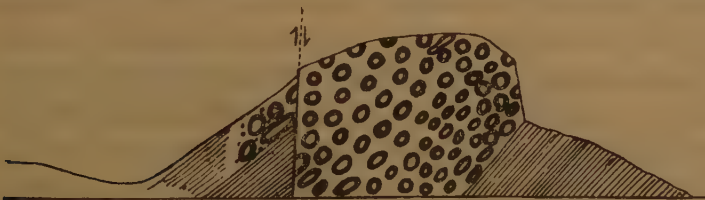


Fig. 2 Cross section of Stark's Knob, showing general relation to the slates, and the gross ball structure of the mass.

that on the southeast, n. 54° e. The southeastern fault is downthrown on the northwest, as on this side there is to be seen the slate underlying a mass of trap on the southeast of the fault. The complete relations of the igneous to the sedimentary rocks on this side are not shown. Figure 2, which is a diagrammatic representation of the cross section of the knob and its peculiar internal structure, shows this fault, but the figure is purposely drawn with some vagueness on the extreme left of the igneous rock (pl. 4).

To sum up the geologic relations of the Stark's Knob igneous mass, it is surrounded on all sides by the Hudson river slates. The principal mass is relatively faulted down into these sedimentary rocks on the south and east. To the eye there appears no distinct evidence of contact metamorphism; yet the mass appears to be the superficial portion of a body which extends downward into the slates and, from its general form and

Plate 5

H. P. Whitlock, photo.

VOLCANIC NECK, SCHUYLERVILLE, SARATOGA CO.

North side showing structure

below the point to which explosive products may have fallen back in the volcano there to become embedded in still hot lava. Certainly the gross structure of the rock recalls many lava sheets with locally formed explosive products, and the same structure is to be observed in the lava flows of the Newark formation of Triassic age in the Connecticut valley[1] (fig. 3). The accompanying photograph, plate 5 of the walls of Stark's Knob shows the general structure.[2]

The fragment shown in figure 2, lying south of the fault, is more massive than the main stock, and the ground mass

Fig. 3 Sketch of a portion of the western wall of Stark's Knob, showing the gray, scoriaceous interior of the lava balls, the basaltic, jointed crust, and the fissile, devitrified, volcanic glass surrounding the lava balls.

approaches more nearly the dense, dark basalt, but here are also developed amygdules.

A hand specimen obtained here displayed fairly coarse crystals of plagioclase, indicative of an intratelluric origin, such as are common in the diabase of many dikes. This combination of the characteristics of dike rocks and of effusive explosive products makes Stark's Knob one of the most interesting igneous occurrences, small as it is, within the limits of the State.

---

[1]Emerson, B. K. Diabase Pitchstone and Mud Enclosures of the Triassic Trap of New England. Geol. Soc. Am. Bul. 1897. 8:59-96. For an illustration of the ball structure at Meriden Ct., see Davis, W. M., The Lost Volcanoes of Connecticut. Pop. Sci. Mo. 1891, p. 221, fig. 1; U. S. Geol. Sur. 18th Rep't. 1898. pt 2, p. 65.

[2]These views were obtained for the museum by Messrs H. C. Magnus and H. P. Whitlock.

Several details of the rock structure remain to be noted.

Jointing of the lava crusts. The globular surfaces of the lava crusts of the balls are beset with a network of cracks perpendicular to the surface. The general appearance of these joints as they are revealed on cross sections of the structure, is shown in figure 3. On exposed walls, the lava crusts frequently fall to pieces in short polygonal joint columns similar to basaltic columns.

So far as I have seen them, these joints do not penetrate the scoriaceous interior of the balls or the limestone inclusions except it be in one or two cases of the latter rock, as shown in figure 4, where dikelets cut across the inclusions:

Fig. 4 Sketch of an included, partially absorbed block of limestone, showing two dikelets.

These dikelets are in all cases conterminous with the crusts of dark, dense rock surrounding the limestone. In one instance as many as three parallel cracks in the limestone inclusion have thus been filled. These inclusions are notable at the northeastern corner of the knob.

The inclusions of limestone point to an irruption through the lower paleozoic limestones which must occur in this field beneath the Hudson terrane. It is questionable whether the present color of the limestone can be taken as evidence of the original rock having been a white crystalline limestone, since the organic matter which gives the dark color to the Lower Silurian limestones of the upper Hudson valley would be driven off in the heating of the rock. The inclusions may be appealed to as evi-

dence that the trap came up through the Silurian and subjacent terrane, as held in this paper, and that the rock is not to be regarded as an in-faulted remnant of a lava flow once covering the Hudson terrane in this vicinity.

The occurrence of these inclusions surrounded by the lava crusts throws some light on the origin of the ball structure. These foreign fragments having absorbed edges would doubtless rob the surrounding lava of heat and thus become centers of cooling. The lava next to the inclusions, thus robbed of some of its heat and further altered in composition by the absorption of lime carbonate, might cool more quickly and with a different structure from that of the ground mass. In this view the lava crusts are tachylitic variations of the magma both about the limestone inclusions and about the cindery nodules. The pumiceous nodules, resembling the centers of many so called bombs, evidently may arise from the occlusion and segregation of gases in the lava. The explosive expansion of these gases would produce a sudden lowering of temperature, however slight, even under the conditions of a hot magma, possibly sufficient to determine the initiation of cooling in the contiguous lava, and thus would, in conjunction with the chemical reaction on the lava, lead to the development of a tachylitic zone in the basalt about the gas-charged, vescicular lava. This effect would arise as well from slaked limestone inclusions as from simple gas-charged lavas. In the case of the limestone, the gas would be derived from the absorbed portion of the rock.

The surrounding ground mass with a flowage structure, in which such lava balls are commonly embedded, evidently owes its structure to later and more rapid cooling.

The fine grained ground mass with fissile structure is much disintegrated at Stark's Knob. It appears to the eye in many places to be clayey or sandy, often weathering to a black, sandy mud. It is frequently ramified by small calcite veins. Where fresh exposures occur, the rock has a resinous luster and is here taken to be a diabase pitchstone. It has not been studied in thin sections.

Stark's Knob as a source of road metal. This occurrence of trap affords a small supply of the best road metal obtainable in the upper Hudson valley, and, if judiciously employed as the surface dressing, would serve to make macadamized roads in the vicinity. The outline of the base of the knob has a north and south extension of about 320 feet and a breadth east and west of 240 feet. Assuming the volume of trap on this base to have an average thickness of 15 feet above the level at which it might be advantageous to work the material, there are here approximately 117,000 cubic yards of rock in place available for local road metal (*see* pl. 6).

PETROGRAPHY AND AGE OF THE NORTHUMBERLAND ROCK

BY H. P. CUSHING

Introduction. The material sent me for examination consists of several fragments which have come from either the crusts of the lava balls described by Professor Woodworth, or else from the surrounding ground mass in which the balls are embedded; also a single specimen of the rock from the south side of the fault. There are no specimens of the scoriaceous material forming the inner portion of the balls, nor of the limestone inclusions. All the material is so badly altered that a satisfactory optical and chemical study of it can not be made, and the rock has no special petrographic interest. The field occurrence is of great interest, as shown by Professor Woodworth. There remains the matter of correlation.

Petrographic description. The material from the throat shows a black, fine grained to aphanitic rock, with frequent, calcite-filled amygdules and many seams and patches of the same mineral. The two slides made from it differ mainly in grain.

The finer grained rock consists of a network of minute feldspar laths, with a general radial or else spherulitic arrangement. They show no twinning and for the most part extinguish nearly parallel to their longer axes. They are studded with minute magnetite crystals, and belong to the oligoclase andesin series.

The interspaces are filled with opaque, decomposition products. It is not certain that the point of crystallization of augite

Plate 6

H. C. Magnus, photo.

VOLCANIC PLUG, SCHUYLERVILLE, SARATOGA CO.

View from the east showing relief of the knob and accessibility of the rock for road metal

had been reached. In the neighborhood of the amygdules specially it seems quite certain that at least some glassy base remained. Irregular masses of calcite are frequent throughout, and the presence of some olivin is indicated by the crystal outlines remaining, though the mineral is so utterly decomposed (showing a mixture of quartz, calcite and opaque uncertain material) that no positiveness is possible.

The other rock is somewhat coarser. It shows rather abundant olivin, wholly altered to a greenish, chloritic aggregate. The determination is based on the shape and size, it having been plainly the first mineral to form. The feldspars are in two sizes, both tending to the long, lath shape, and mostly showing twinning. The greatest observed extinction is 22°, but the majority are much less, between 10° and 15°, and most of the laths which show no twinning extinguish nearly parallel. There are likely present therefore both labradorite and andesin, and perhaps oligoclase as well. The mineral is not fresh, being largely altered to calcite and quartz. The interspaces are filled by a mixture of calcite, and chlorite aggregate, likely the result of augite decomposition. Considerable magnetite is present. The rock seems to be an olivin-diabase-porphyrite, and like many olivin diabases shows considerable preponderance of feldspar over augite, resulting in only a rough approximation to the ophitic structure.

Both rocks are amygdaloidal. The universal filling is calcite, with an outer rim of clear, glassy quartz, commonly very narrow and sometimes absent. The two are invariably separated by a sharp, narrow, dark band of uncertain nature. The quartz was of course deposited first, no doubt from silicious waters while the material yet retained some residual heat. The calcite was later, perhaps much later.

Both these rocks have the characters of surface lavas, and could not have solidified at any great depth beneath.

The rock from south of the fault is not amygdaloidal and of considerably coarser grain. It is also the least altered of any, and is a perfectly normal olivin diabase. Minute, glittering feldspar laths are easily made out by the eye.

The original rock would seem to have been quite rich in olivin. It is now wholly altered, mostly to chlorite, though in some of the larger individuals patches of serpentine remain in the midst of the chlorite, the whole combination showing distinct mesh structure.

The pyroxene is also wholly altered, and to a mixture of calcite and chloritic aggregate. Some of the calcite is in crystals of considerable size, and some of these present apparent pyroxene outlines, as if in these cases the alteration had been to calcite simply. Not a particle of unaltered pyroxene could be detected. In many instances it is not possible to be sure whether the original mineral was olivin or pyroxene, but in the majority it is possible. There is considerable magnetite present in minute crystals, but the amount is rather scant in comparison with most diabases.

The feldspars are of the long, lath shape, and the majority show multiple twinning. The extinctions are, in general, not over 15° but in two or three cases run up to 20°. This may indicate the presence of both andesin and labradorite, but in any case the feldspar is not very basic. The alteration products of the augite fill the interspaces between the feldspar laths, giving an approximation to the ophitic structure, though by no means well marked.

The holocrystalline, nonamygdaloidal and nonporphyritic character of this rock shows that it must have cooled under different conditions from the others; and Professor Woodworth's paper indicates the likelihood of this, since a fault intervenes, which downthrows to the north, implying that the rock on the south is from a deeper seated source. Professor Woodworth writes me that his idea is that one passes here from the throat, with ball structure, to a conduit in which the lava cooled under different conditions, but that the exposures are not sufficiently good to permit of certainty in the matter. The sections would seem to reinforce this interpretation.

Correlation. Though the rock possesses no special petrographic interest, being an ordinary rotten diabase, it is inter-

esting from another standpoint, that of its probable age and associations. Its surroundings permit no more definite assertion concerning its age than that it must be younger than the Hudson slates which it cuts. This renders a reference to the pre-Cambrian diabase of the region impossible, though there is a strong resemblance in the rocks. There remain the basic eruptives of the Champlain and Mohawk valleys and the traps of the Trias, as representatives of the only known periods of vulcanism of post-Ordovician date in the region. The rock must either be referred to one or the other of these, or else must stand by itself as the single representative of a heretofore unknown time of igneous activity, a most unlikely though not impossible contingency.

The eruptives of the Champlain valley are younger than the Utica shale of the Ordovician, though their precise age is unknown. They comprise both acid (bostonites) and basic (camptonites, monchiquites and fourchites), basaltlike rocks, of the sort usually found in association with nephelin syenite eruptives, such rocks occurring in Canada directly to the northward. With the exception of one single dike noted by Kemp, none of these rocks are diabases, though the known number of basic dikes is large, and it would therefore seem to be at least an open question as to whether this dike should be properly classed with the remainder.[1] Its nearly north-south trend is certainly exceptional for the region, and it may be a stray dike of Triassic age.

The eruptives of central New York are all exceedingly basic rocks, alnoites and peridotites. Smyth's recent discovery of melilite in the Syracuse rock would seem to indicate the probability that all of these rocks may prove to be alnoites.[2] The dikes about Manheim cut Ordovician rocks, those at Syracuse cut the Silurian, and, if the dikes at Ithaca belong to the same group, a late Paleozoic age is indicated for all, since these cut the Upper Devonian.[3] They are so utterly different in character

[1] U. S. Geol. Sur. Bul. 107, p. 48.
[2] Am. Jour. Sci. ser. 4. 14:26-30.
[3] Kemp, J. F. Am. Jour. Sci. ser. 3. 42-410.

from the Northumberland rock that there can be no question of correlating them.

The Triassic traps are uniformly diabases. They are in general quite similar to the Northumberland rock except that olivin is usually lacking in them. But Professor Emerson, while remarking on the absence of olivin in the main trap sheets of the Massachusetts Trias, reports it as more or less abundant in the smaller dikes which cut the adjacent gneisses, and in some of the later plugs.[1] It is also sometimes present in the New York and New Jersey traps. Therefore the presence of olivin, while enforcing caution as to the reference of the Northumberland rock to the Trias, is not an insuperable objection.

The writer is therefore disposed to refer the Northumberland rock to the Trias, because of its character, but it should be emphasized that it is a disposition simply. It is put forward as a working hypothesis. The first sight of the thin sections suggested the reference, and it is of interest to note that Professor Woodworth had come to the same conclusion on wholly different grounds. An obvious objection to the reference at once arises, its isolation and distance from any known Trias traps and sediments. In answer to this it may be legitimately argued that the remnants of the Trias formation can give no idea of its original extent, and that the traps might well therefore have a much wider distribution at present than the sediments, since they came up from beneath. Also that there seems no *a priori* reason why they may not have had an original wider distribution than the sediments, since the disturbances which characterized the period can hardly have been confined to the actual troughs where deposition was going on, or, rather, where extensive deposition was going on. To quote from a letter of Professor Woodworth's:[2]

I have thought from the habit and mode of occurrence of this rock, that it may be a part of the Triassic eruptions lying on, or

[1] U. S. Geol. Sur. Monograph. 29:412,493.

[2] Professor Woodworth and I arrived at the opinion of the Triassic age of the Northumberland rock independently, from different lines of evidence and prior to entering into correspondence on the matter.

near, the floor of a former Triassic area north of the Highlands of the Hudson. Such a view of the origin of the Hudson valley north of the Highlands is borne out by the evident structure of the valley south of the Archaean ridge, and is not incompatible with the structure of the Hudson and other terranes to the north.

A final reason for the reference of the rock to the Trias is its near-surface character. The field occurrence as described by Professor Woodworth, and the character of the rock, both megascopic and microscopic, indicate surface volcanic action. Now, while surface lavas are abundant in the Trias traps, we know of no such among the eruptives of the Champlain valley, the basic rocks there all being in the dike form. To be sure, the rocks of the latter cooled at no great depth below the surface and may have outflowed there, but no vestige of such rocks now remains.

In conclusion, the only known New York igneous rocks to which the Northumberland rock can be referred, are those of the Champlain valley, and the diabases of the Newark series. Because it is a diabase, and a volcanic, rather than an intrusive rock, the latter reference is regarded as the more probable. But it must be reiterated, at the risk of becoming wearisome, that the evidence is far from decisive, and that this view is promulgated as a working hypothesis simply.

LATEST AND LOWEST PRE-IROQUOIS CHANNELS BETWEEN SYRACUSE AND ROME

BY

HERMAN L. FAIRCHILD

CONTENTS

LATEST AND LOWEST PRE-IROQUOIS CHANNELS BETWEEN SYRACUSE AND ROME

Location and character of the channel phenomena

A former report of the writer[1] gave descriptions of the ancient, elevated stream channels which lie across the north-facing slopes of the great ridges between Syracuse and Oneida. Those high ancient channels were cut by eastward flowing waters escaping past the front of the glacier when the ice sheet was slowly melting away from the higher ground. In that report mention was made of the later and lower channels, which lie on the plain at the north edge of the slopes. A description of these low channels will now be given.

These lowest channels were the last formed in the district previous to the establishment of Lake Iroquois.[2] They lie at the south edge of the Ontario plain, close against the foot of the slopes or against the outlying hills. They form level, water-planed stretches which are utilized from Syracuse to Rome, about 40 miles, by the New York Central Railroad, and between Syracuse and Canastota by the Erie canal. The accompanying maps (pls. 7-10) indicate the location of the channels and stream-cut banks.

That these channels were formed at the immediate edge of the glacier, by stream flow squeezed between the ice front and the high ground or hills on the south, is clearly shown by the absence of north banks to the channels for most of the distance. At many places the lower land surface is a smooth plain, sloping gently to the northward. The glacier is the only conceivable

[1] N. Y. State Geologist. 20th An. Rep't. p. r119. In the introduction to that paper will be found a list of the writings on the subject of ancient stream channels in western New York.

To clearly understand the present paper the reader should have in hand four sheets of the New York State topographic map, namely, Syracuse, Chittenango, Oneida and Oriskany. These sheets may be obtained for 5 cents each from the United States Geological Survey, Washington D. C.

[2] A map of the glacial lake Iroquois is published as plate 19, in the 20th annual report of the state geologist.

barrier that could ever have held the waters against the slopes of the higher ground so as to produce the bluffs by stream erosion. The glacier was not only a competent agent, but all the facts prove that it was *the* agent.

Where embayments held slack water, as at Oneida, the banks and channel features are wanting. The salients or exposed hills, whether drumlins, moraines or outliers of shale, have their north flanks cut into banks or bluffs, attesting the work of vigorous currents. At many places these long, steep banks are very conspicuous phenomena. (*see* pl. 11–31) At first sight the suggestion might be entertained that the banks had been produced by wave cutting, specially since they lie near the level of Lake Iroquois, and in the same great basin. A very little study of the subject, however, disproves the idea of wave erosion. In order to forestall profitless discussion, the argument may be briefly stated.

As a general statement, it may be said that the banks do not have the characters of wave-cut cliffs. Opportunity for comparison is at hand, as only a few miles to the northward are the undoubted wave-cut cliffs on the drift hills which stood as islands in the waters of Lake Iroquois. The slopes under discussion have an entirely different form, character and relationship to the surrounding surfaces from the Iroquois cliffs. These stream banks lie on the side of the hill or salient where a theoretic stream would erode, and nowhere else. They do not occur on the sides of the hill where wave action should have been effective if the latter were the agency. The banks do not curve around the hills like wave-eroded notches, but usually form long, comparatively straight bluffs, strongest on the northwest flanks. Many of the banks lie at an altitude much above the level of Lake Iroquois, and above the highest undoubted Iroquois cliffs in the Syracuse region. The banks are cut in the Salina shale rock, and are larger and stronger every way than the Iroquois cliffs. Indeed the strongest of the Iroquois wave cuttings in the Syracuse region does not compare in quantitative effect with the weaker of the stream-cut rock bluffs. Moreover,

these rock banks are at such slight altitudes above the plains which they face that standing water could not have had enough depth to produce efficient wave action. The argument may be condensed in the broad statement that the entire phenomena of the banks, their form, position, relation to surrounding topography, and all other characters, prove their stream genesis. These characters will appear in the descriptions following, with the illustrations. It should be said, moreover, that the history of the glacial retreat from the region and the history of the glacial waters (given in former writings) theoretically necessitate these low channels, and that they were predicated from the knowledge of the earlier, high level phenomena.

Relation of the channels to the ice front and to Lake Iroquois

At one time the continental glacier covered all of New York State. Slowly the front of the ice body receded, because the melting exceeded the advance, till all the southern part of the State was free from ice. At the time which we are now considering the lobe of the Labradorian ice sheet that still rested over the basin of Ontario was wasting away. By its own weight it had, as a plastic body, a spreading flow and pushed southeastward over the low ground of Oneida lake district against the higher ground between Syracuse and Rome. The directions of flow are best shown by the attitude of the drumlins, the ice-molded drift. The waters which were impounded in the valleys fronting the ice, derived from north-flowing streams and from the melting of the ice itself, found their way past the front of the ice to the Mohawk valley. At the later stage these waters were augmented by all the overflow from the basin of what is now the "Upper Great Lakes," or from as much of the area as the ice had abandoned, because the St Lawrence outlet was still blocked by the ice.

It appears certain that the ice disappeared from the higher ground between Oneida and Rome earlier than it did from the region farther west, near Syracuse.[1] The front of the ice sheet

[1]See former report, p. 129, 130.

apparently had a trend oblique to the south border of the basin, thus making an open angle toward the east. The ice front therefore receded from the higher ground progressively from east to west. In consequence of this oblique position and westerly recession of the ice front, the eastern channels were cut earlier than the more westerly channels of corresponding levels. It follows that the several low level channels which we are considering in this paper are not all of one series. The channels toward Rome are to be correlated with some of the high level channels toward Syracuse, described in earlier papers, while the low level channels near Syracuse probably poured their flood into the primitive Lake Iroquois, which then occupied the low ground toward Rome.

The final outlet of all the glacial waters was over the col at Rome to the Iroquois river and the Mohawk valley. As the ice front receded from Rome the lake (Iroquois) was initiated, and it enlarged at the expense of the glacier till it filled the Ontario basin.

The channels which have an altitude over 445 feet were always above the lake level. Those toward Syracuse with altitude 430 feet and lower probably poured their waters at first directly into the forming lake, and later may have been flooded by the lake. This topic is discussed in the next section.

Altitude and deformation of the channels

The present hights of the channels above sea level are indicated by the map contours (pl. 8-10). It will be observed that the altitudes do not decrease toward the east as might be expected. On the contrary, the highest channels are those beyond Oneida, while the lowest are those at Syracuse. There are two causes of this discrepancy. The most important is that the several channels are not of one series, but were cut at different times and independently of each other. The second cause is that the absolute and the relative altitudes of the channels are not quite the same now as when they were made. Since the ice retreat the land surface of the region has been uplifted and possibly warped.

The amount of deformation along the line of the channels has not been determined with precision, but can be given approximately.[1]

The only reliable knowledge that we now have concerning the changes of altitude of the region is based on the deformation of the later Iroquois plane. Such deformation is all post-Iroquois. The present altitude of the Iroquois outlet at Rome is 430 feet. Allowing 15 feet for depth of water at the outlet would make the water surface of the later Iroquois 445 feet. A strong gravel bar close to Wampsville station and 10 miles southwest of Rome has an attitude of 446 feet. East of Syracuse about 13 miles, and 2½ miles east of Kirkville, is a strong, recurved bar crossing the canal. By canal datum the western end of this bar, which was exposed to the north and west winds, has elevation of 447 feet, while the portion curving south across the canal is 440½ feet. One mile southwest of Manlius station and 7 miles east of Syracuse is a bar on the east side of a hill, south of the tracks, with elevation of 437 feet, by the railroad datum. By the same datum a bar 4 miles west of Syracuse and ½ mile east of Fairmount station has altitude of 441 feet, but it lies in a narrow valley, protected from the northerly winds, and probably is below the lake level. It would appear, therefore, that the Iroquois plane has about the same altitude at Syracuse as eastward toward Rome and has suffered no considerable warping in the region.

The eastern channels, between Rome and Oneida, which were all formed previous to the initiation of Lake Iroquois, have experienced practically the same amount of uplift as the Rome col. The channels at Syracuse have participated in all the movements of that locality since the earliest phase of Iroquois. But they are below the lake level of the place. The bottom of the Burnet Park channel is 400 feet, according to the map contours, and that of the Syracuse channel, leading east from the city, is about 420 feet, and both channels are filled to unknown

[1] A brief discussion of the deformation in central New York will be found in two earlier papers by the writer: Geol. Soc. Am. Bul. 10:66; N. Y. State Geologist. 20th An. Rep't, p. 111, 112.

depths with recent accumulations. This inferiority of the channels to the Iroquois lake surface may be at least partly attributed to the excavating power of the great rivers, comparable to Niagara. The lower section of the Burnet Park channel is a cataract gorge, and might have been cut by the plunging waters to a depth of many feet below the surface of the receiving lake. The inferiority of the channels may also be explained by assuming that Lake Iroquois had a lower level in the Syracuse region in its earlier phase than it had in its later phase. Such a change in level would have resulted from the relative lifting of the outlet during the life of the lake. It is quite possible that some westward tilting of the Iroquois basin occurred during the life of the lake, but we have no measure of it. In the former report it was shown that between Richland and Watertown there is slight evidence of north and south tilting during Iroquois time, though the post-Iroquois tilting amounts to over 5 feet to the mile.

The data at present available for this discussion are not sufficient for definite conclusions.

Description of the channels

Channels at Syracuse

On the meridian of Syracuse the northernmost channel leads east from the center of the city. Related to this is another and lower channel on the west leading into the city. A line joining the two passes directly through the center of the city.[1] The western channel (*see* pl. 11-13) which we may call the Burnet Park channel, heads 3½ miles west of the center of Syracuse and 1 mile south of Solvay village. The four corners south of Solvay are on the north bank near the head of the channel, and the Solvay Process Co.'s carrier cable crosses the head or intake of the channel. The map contours clearly show the depression. The altitude of the head of the channel is, by the map, 500 feet above tide. The upper part of the channel, leading southeast, is in limestone, probably the

[1]See plate 8, which uses a portion of the Syracuse sheet.

"Waterlime," and is cut into irregular ridges and hollows, which have been subdued by subsequent weathering. For over a mile the channel has only moderate slope, then curving east it declines rapidly and soon drops by a cataract cliff some 30 or 40 feet, making a total fall of over 100 feet in 2 miles. This rapid descent is in consequence of the river having cut down through the harder calcareous and gypsiferous rocks to the underlying softer shales. The present topography in the lower part of the channel is irregular, and might suggest morainal drift; but it is cataract work in Salina shales, modified by recent stream work and weathering. The present floor of this channel has an altitude of less than 400 feet near the mouth, and is at least 40 feet below the later plane of Iroquois waters in the vicinity. This channel, leading into the Onondaga depression, was the outlet for the glacial waters from the west till the ice front had melted away from the great mass of moraine and drumlin drift which lies west of Syracuse, thus opening a passage north of the drift mass.

The business section of Syracuse and all the south part of the city occupy the detrital plain or delta which accumulated in the Onondaga embayment by the great river which cut the Burnet Park channel, and partly through more recent work of the Onondaga creek. During the life of the glacial river the site of Syracuse was occupied by a shallow lake reaching south up the Onondaga valley. The waters of the Syracuse lake found escape eastward by the conspicuous channel leading east from the city and utilized by the canal and railroads. (*see* pl. 14–19) This grand river channel is at least ⅓ mile wide. The floor of the channel at the divide has altitude of about 415 feet. It is a stretch of flat, swampy ground as yet unused for building and is said to have a great depth of marl under peat. The Erie canal is carried along the south wall of the channel with hight of the water surface 430 feet. This channel, which we will call the Syracuse channel, heads in the city about where the New York Central Railroad crosses over the canal and extends, north

of east, some 3 miles to East Syracuse, where it expands into the broad, low plain in which lies Oneida lake.

Channels between Syracuse and Oneida

Eastward from Syracuse for 25 miles, to beyond Oneida, the phenomena of river erosion are interrupted and fragmentary, but not the less interesting. The channels and banks are indicated on the accompanying map and pictured in the plates 20–26. Following is a brief description.

Going east from Syracuse by the New York Central Railroad, the first of the stream-cut banks, the characteristic river phenomena of the region, will be seen 2 miles beyond East Syracuse, at the first road crossing. Close to the railroad on the south side is a conspicuous concave bluff cut out of the northwest flank of the hill composed of Salina shale. The south side of the same hill, by the West Shore Railroad, shows no such erosion. This bluff is a type of the stream-cut banks which occur on the north or northwest sides of the exposed hills or salients in the Syracuse-Oneida district.

By referring to the sheet, plate 8, the reader will see that 1 mile south of the hill above noted a similar hill occurs, which also has pronounced erosion on the northwest flank. Between the two hills is a well developed channel, traversed by the West Shore Railroad.

Previous to the cutting of the banks on the two hills the escaping glacial waters were forced to flow alongside the high ground southeast of these hills and north of Fayetteville. The abrupt slope, fronted by low swampy ground, is clearly shown on the adjoining edges of the Syracuse and Chittenango sheets are reproduced in plates 8, 9. The horizontal, clean cut outline and the abrupt, concave slope are features produced by stream flow, the river having been crowded by the glacier against the rock wall for a long time. The canal takes advantage of this horizontal bank and follows it all the way from Limestone creek east, past Manlius Center, to Green lake outlet, about 2½ miles. The same relation of the canal to the banks is preserved to beyond Canastota. In the entire distance of over 20 miles from Syra-

cuse to Canastota the canal, by taking advantage of the river-graded stretches, is enabled to dispense with locks and to preserve a single level, the water surface being 430 feet.

On the meridian of Kirkville is a series of channels. The three corners 1 mile south of the village lie in a pronounced channel, and another scourway 40 feet higher lies a short distance south, on the slope of the great hill. These two scourways unite eastward into a single channel. This channel is probably to be correlated with the higher one on the southwest in which lie Round and Green lakes, and which was described in the former report (p. 128). The waters which cut the Manlius Center bluff also excavated, farther east, the large channel ½ mile south of Kirkville. The latter river bed extends east as a swampy tract for over a mile, and southwest of the canal widewaters it is bounded by a steep, concave bluff (*see* pl. 20). Around this swamp and bluff the north and south road makes an eastward bend, as shown on the map. The eastward continuation of this channel, which we may call the Kirkville channel, forms another remarkable bluff along the south side of the canal widewaters (*see* pl. 21, 22). This cliff, 40 to 50 feet high, is even more striking than the Manlius Center cliff, as it has no high ground behind it. It is wholly Salina shale, which is here used for the manufacture of brick by the Kirkville Brick Co. The bluff is plainly seen from the New York Central Railroad, ¾ mile away.

A mile north of these channels is another notable bank, a mile east of Kirkville station, and northeast of the village. An outlier of shale forms here the most northerly projection of the high ground between Syracuse and Oneida. To pass this salient, the two railroads make a decided bend in an otherwise straight course, and pass close to the river-cut bank. This point of the promontory felt for some time the corrosion of the glacial waters, and the effect is seen in a strong, conspicuous, curving slope in rock, facing north and close to the railroads (*see* pl. 23). Lying some 10 feet higher than the base of the bluff, the canal finds passage through a depression south of the bluff. The first

canal, "Clinton's ditch," followed the foot of the bank, where the West Shore Railroad now passes.

In the midst of the embayment at Chittenango is a great mass of morainal drift overlying rock which has a very prominent bank on the northwest flank (*see* pl. 24). South of, or behind, this islandlike mass is a large river channel about the dimensions of the Syracuse channel. Whether the floor is rock or alluvium has not been determined, but in either case the form and surface are due to the sweeping by a great river before the ice had opened a passage north of the outlying hill. The canal follows the north side of the broad channel.

At the east end of the Chittenango channel the waters were thrown against the steep northwest slope of another rock mass and another high bank was formed, a mile northeast of Sullivan, comparable to those already described east and west of Kirkville. One mile farther east another good bank occurs. Both of these banks are plainly visible from the New York Central Railroad, a mile distant, and more clearly from the West Shore, which passes closer. At an earlier phase than the cutting of the channels here noticed the glacial waters had flowed south of the hills, excavating a channel 2 miles east of Sullivan. The latest stream cutting in this section formed a bank about 2 miles east of Chittenango station and close to the West Shore Railroad.

The next bank to the east occurs 1½ miles west of Canastota. For a mile it stretches along the railroads and into the village. A mile west of the village the New York Central tracks have cut away the point of the salient, and there destroyed the original bank, while a filling of the West Shore has obscured another section. This bluff, with its extension east of the village, shows well in its curvatures the effects of stream meandering. Toward the western end the river was compelled to swing around the rock slope in a curve convex to the north. In reaction from this the current veered to the south, so that near the village the bank is concave to the north (*see* pl. 25). An earlier channel lies south of the hill, 1 mile southwest of

Canastota. An east and west highway follows the more ancient scourway for a mile.

One of the most conspicuous banks of the entire series, and one most readily seen, is in Canastota village, just east of the railroad station (*see* pl. 26). Like all the others the bluff is in shale, nearly vertical and about 30 feet high. One half mile east the railroads cut the projecting bluff. Still farther east the waters excavated a pronounced concavity in the rock slope, which still remains in timber (*see* pl. 27). Yet farther east the bank is again convex, curving around the east end of the hill. The height of the channel floor at the base of the Canastota bluff is 430 feet, about the same as the railroads.

Two miles east of Canastota the railroads make a cutting through a gravel bar which was built in the shallow waters of Lake Iroquois on the front of the delta built in the lake by Cowaselon creek. The bar appears south of the railroads and passes northeast, across the tracks, and crosses the highway about ¼ mile north of Wampsville station. The hight of the bar is about 446 feet. The channel floors, east and west, are about 430 feet.

About 2 miles west of Oneida is another bank which extends along the railroads for over a mile and then curves around the north side of the hill southwest of Oneida. The railroads have so cut into the bluffs as to destroy or obscure the original characters of the ancient banks.

At Oneida is a broad embayment where the valley of Oneida creek widens out into the low plain. During the glacial retreat over the area this embayment was occupied by standing water, and a variety of interesting phenomena are found, some of which were noted in the former report.

Channels between Oneida and Rome

Between Syracuse and Oneida the north edge of the high ground has an east and west direction, and in consequence the stream phenomena follow this course. Between Oneida and Rome the trend of these features is to the northeast. Against the northwest-facing slope the ice sheet rested for an indefinite

time, during which large streams flowed past the ice front over into the Mohawk valley. The ancient stream channels are well developed and form a nearly continuous scourway for about 10 miles. The most westerly cutting is 3 miles northeast of Oneida. The series leads northeast, curving around the higher ground, convex to the north, and ends at Stanwix village, 2 miles southeast of Rome. Here the glacial waters found free escape to the sea by the Mohawk valley. The channels are utilized by the New York Central Railroad for over 6 miles, from west of Verona to within 4 miles of Rome. (*see* pl. 10)

These channels were formed earlier in time than those west of Oneida, and are quite different in character. Unlike the western channels they lie on a land surface of moderate relief and of moderate slope, and not against steep hills. The ice edge was probably thinner here and less aggressive. In consequence of these different physical conditions the channels are more continuous, relatively broader, and the north walls are more commonly developed. In a word, the channels have more the ordinary form of abandoned river channels, while the isolated bluff phenomena, so pronounced west of Oneida, are scarcely found. At a few points the channels are comparable in size to the great ones at Syracuse. They are probably the work of rivers of smaller volume than those which cut the western channels.

On the sheet, plate 10, it will be noticed that, in the stretch of country from Oneida to Rome, not only the railroad but nearly all the highways conform to the land slope, being either parallel to the stream channels, northeast and southwest, or at right angles to this. For convenience in description, the sides of the channels will be here referred to as north and south, and directions along the railroad and channels as east and west. On this sheet may also be noted seven living streams, in the seven miles of channel from Verona to beyond Greenway, having a northerly course and striking the channels obliquely. These modern creeks have partially cut and obscured the south walls of the ancient channels at their points of junction. The succession, direction and parallelism of the creeks form an inter-

esting combination of characters, which are not accidental but have their genesis in geologic structure and processes.

Passing east from Oneida by the railroad, and crossing the low ground of the Oneida embayment, with its area of yellow sand knolls, the first clear appearance of channel features is seen a mile west of Verona station. In a short distance it becomes evident that the railroad lies in a well developed channel. The altitude of the channel floor is 465 feet. At Verona station the railroad is cut in the south wall of the channel. One and one half miles east of Verona the south bank is very conspicuous, some 40 rods south of the tracks, the latter resting on a filling in the channel.

At the highway crossing, nearly 2 miles east of Verona, the channel is about ⅓ mile wide, and the south bank is about 40 feet high. The north bank is low but distinct. The floor of the channel is strewn with boulders (*see* pl. 28, 29).

One half mile north of the road crossing above noted is an outlier of "Oneida grit," swept bare over many acres by water action. Preglacial weathering had opened the joints of the quartzose rock so as to make a "rock city," which the ice did not pluck away. The west side of the rock area shows stream erosion, the ground being lower than the channel carrying the railroad.

About ½ mile beyond the highway the railroad leaves the channel and makes a cutting through a mass of drift which forms at this point the north wall of the channel. In this cut the railroad has the highest elevation between New York and Rochester, 477 feet. Here and for a mile east the channel is excellently developed, being at least ⅓ mile wide and the walls 40 to 50 feet high. Plates 30 and 31 are from photographs taken at the next road crossing, at the bend in the tracks, near the Summit View stock farm. The precise altitude of the channel floor near this highway is 459 feet.

Approaching Greenway station, the channel walls diminish, the north bank disappearing entirely. At the station the south bank is not evident, as a hollow from the south joins at this place.

Three miles from Rome the channel blends into the broad, smooth plain which forms here the divide between Hudson and St Lawrence waters. The banks which constitute the south wall curve around the high ground 2 miles south of Rome and end at Stanwix village. These banks were cut by river flow preceding the inception of Lake Iroquois, at a time when the ice sheet still occupied the divide. A strong and conspicuous bluff behind the village, with altitude by the map contours of about 460 feet, tells the fact of the early drainage.

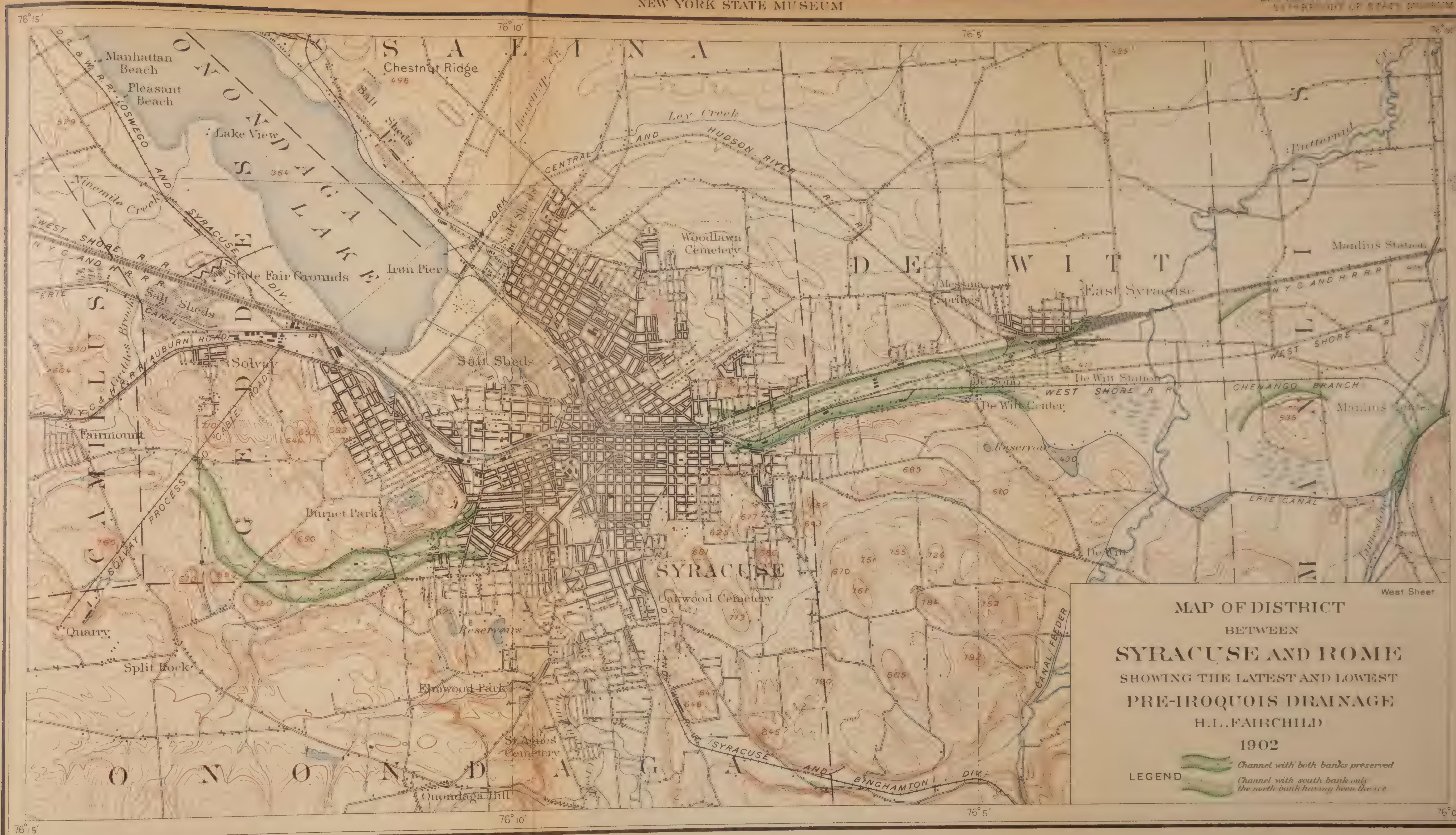
The interval between Rome and Stanwix, about 2 miles, has been swept and leveled by river action. The line of water parting has about the course of the canal and the New York, Ontario and Western Railroad, with altitude of 430 feet. For ages here was the outlet of the great Lake Iroquois and the head of the great river which was predecessor to the St Lawrence.

Relation of these low channels to the high channels

To appreciate the supposed relationship between the channels described in this paper and the channels on the higher ground, the reader should have in hand, for comparison with the maps (pl.7–10) accompanying this paper, plates 15 and 16 in the former report.

The study of the relation between the high and low channels, in both location and altitude, leads to the following tentative conclusions. (1) The waters which cut the high channels across the points of Eaton, West Stockbridge, Cranson and Eagle hills[1] found eastward escape by several channels higher than the Verona-Greenway channels, and lying on the ground west and northwest of Clinton. At that time the lower ground of the Verona-Greenway channels was yet buried under the ice sheet. (2) The Round Lake and Mycenae channels, northeast of Fayetteville[2] probably correlate with the channels described in this paper as lying between Chittenango and Canastota. This series should also include the channels south of Fayetteville and west of Manlius, and probably the earlier cutting of

[1]See former report, p. 123, 124.
[2]See former report, p. 123, 128.



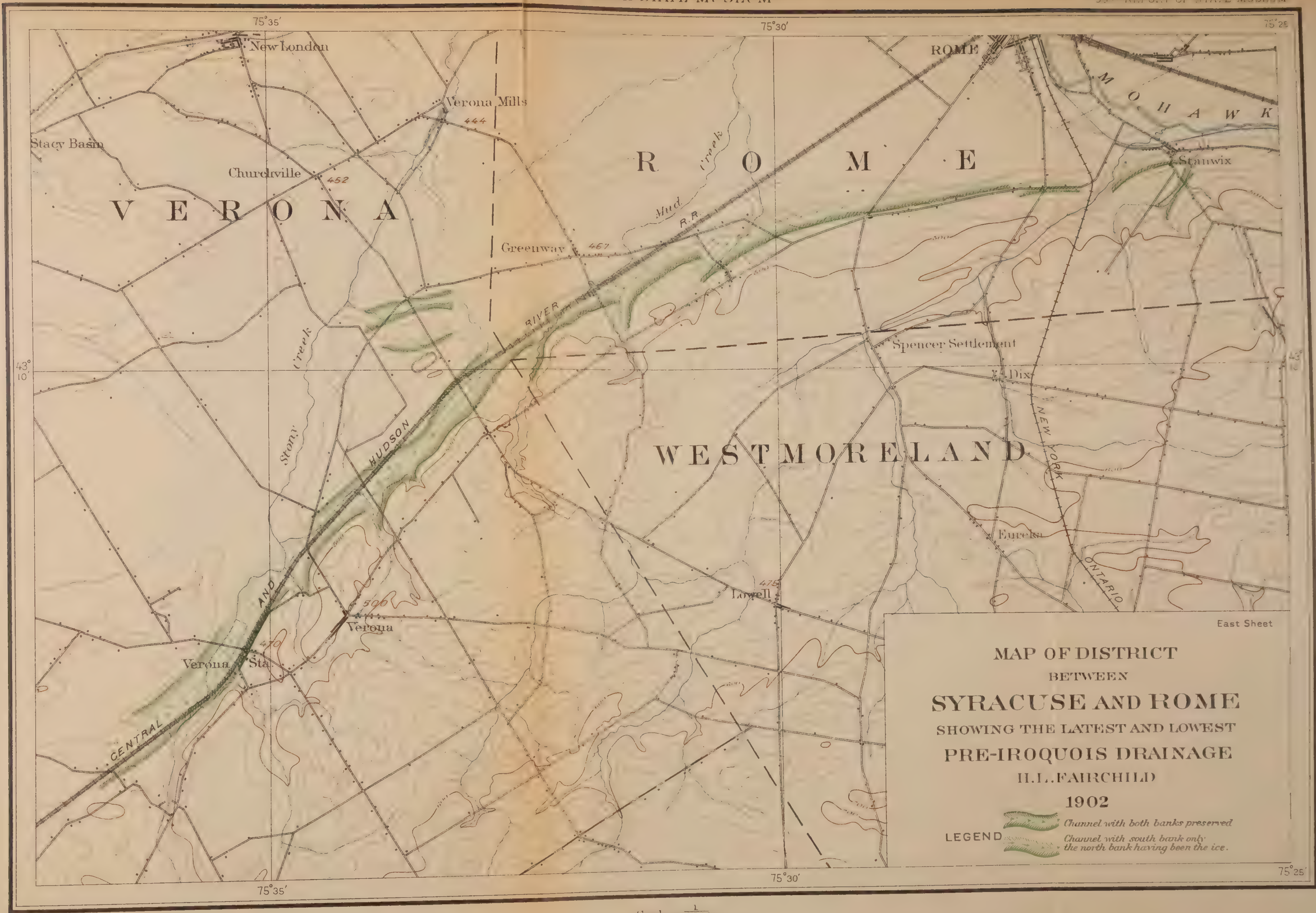
Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.

Datum is mean sea level.



Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.

Datum is mean sea level.

Plate 11

H. L. Fairchild, photo.

BURNET PARK CHANNEL

Western part of Syracuse. Looking northward across channel [compare pl. 12, 13]

H. L. Fairchild, photo.

BURNET PARK CHANNEL

West of Syracuse. Looking upstream, south of west, toward cataract. Orphan asylum at the right. A bank of snow lies at the foot of a section of the cliff [compare pl. 11, 13]

H. L. Fairchild, photo.

BURNET PARK CHANNEL

West of Syracuse. Looking northeast across the mouth of the channel. The city in the background, on the right [compare pl. 11, 12]

H. L. Fairchild, photo.

SYRACUSE CHANNEL

East of Syracuse. Looking southwest across the channel, from Burnet av. West Shore R. R. in the foreground, N. Y. Central R. R. in the middle of the channel, Erie canal at the foot of the south bank [compare pl. 15-19]

H. L. Fairchild, photo.

SYRACUSE CHANNEL

East of Syracuse. Looking west of south across the head of the channel. Syracuse University buildings on the opposite hill [compare pl. 14-19]

H. L. Fairchild, photo.

SYRACUSE CHANNEL

East of Syracuse. Looking east of south across the channel from the head of Vine st. (St Vincent de Paul church). Drumlins southeast of Syracuse on sky line [compare pl. 14-19]

H. L. Fairchild, photo.

SYRACUSE CHANNEL

East of Syracuse. Looking southeast across the channel from near the position of plate 16 [compare pl. 14-19]

H. L. Fairchild, photo.

SYRACUSE CHANNEL

East of Syracuse. Looking west of north across the channel from the south side at Fayette st. Opposite direction from plate 16 [compare pl. 14-19]

H. L. Fairchild, photo.

SYRACUSE CHANNEL

East of Syracuse. Looking east of north across the channel from the same position as plate 18 [compare pl. 14-18]

H. L. Fairchild, photo.

KIRKVILLE CHANNEL

Concave bluff 1 mile south of east of Kirkville. Looking northeast

H. L. Fairchild, photo.

KIRKVILLE CHANNEL

1¼ miles east of Kirkville. Looking south of east at the south bank [compare pl. 22]

H. L. Fairchild, photo.

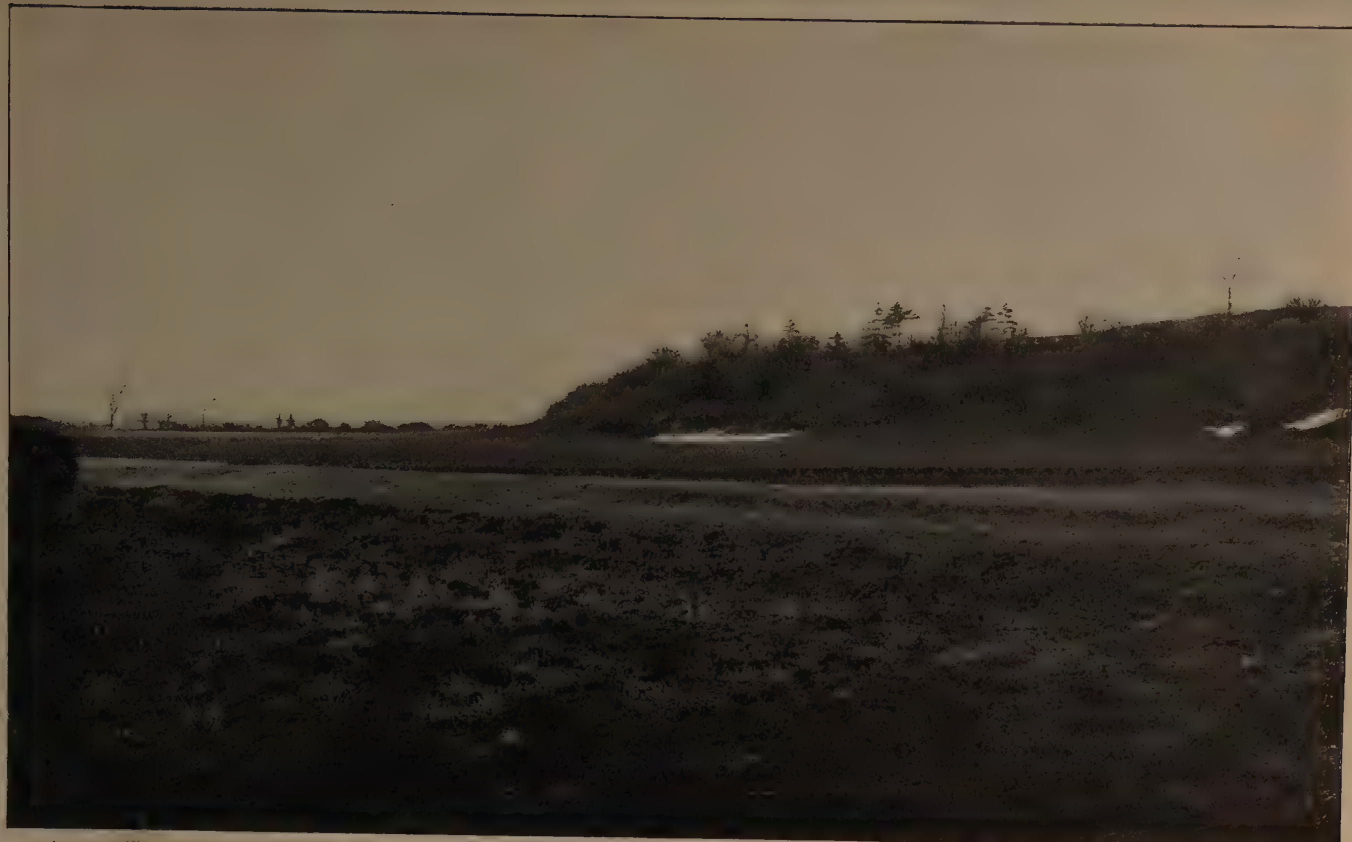
KIRKVILLE CHANNEL

South bank 2 miles east of Kirkville. Looking south of west. Erie canal in the foreground [compare pl. 21]

H. L. Fairchild, photo.

STREAM-CUT BANK

1 mile east of Kirkville station, and 1 mile northeast of the village. Looking southeast. West Shore R. R. makes a cut in the channel bottom



H. L. Fairchild, photo.

STREAM-CUT BANK

1½ miles north of Chittenango and 1 mile south of stations. Looking east from north-south road. Old canal in the middle ground

H. L. Fairchild. photo.

CANASTOTA CHANNEL

Concave south bank, ¾ mile west of Canastota. Looking south of east from West Shore R. R. [compare pl. 26, 27]

H. L. Fairchild, photo.

CANASTOTA CHANNEL

South bank seen from the railroad station. Looking south of east [compare pl. 25, 27]

H. L. Fairchild, photo.

CANASTOTA CHANNEL

Concave bank ¾ mile east of Canastota. Looking southwest [compare pl. 25, 26]

H. L. Fairchild, photo.

VERONA-GREENWAY CHANNEL

1½ miles northeast of Verona station. Looking southeast across the channel [compare pl. 29-31]

H. L. Fairchild, photo.

VERONA-GREENWAY CHANNEL

1¾ miles northeast of Verona station. Looking south from the north edge of the channel. Swamp bottom [compare pl. 28-31]

H. L. Fairchild, photo.

VERONA-GREENWAY CHANNEL

2¾ miles northeast of Verona station. Looking southeast across the channel from Summit View stock farm [compare pl. 28-31]

H. L. Fairchild, photo

VERONA-GREENWAY CHANNEL

3 miles northeast of Verona station. Looking west toward north bank from the middle of the channel. Summit View farm on the right [compare pl. 28-30]

the great "railroad" channel 3 miles southeast of Syracuse. (3) The later life of the "railroad" channel quite certainly added its waters to the flood which cut the bluffs at Manlius Center and those south and east of Kirkville. The waters which occupied the huge channels at Syracuse may possibly have cut the banks on the two hills east and southeast of East Syracuse, and at the last probably poured directly into the early Lake Iroquois.

The Verona-Greenway channels were probably cut at the same time as these at Oneida and Canastota. These carried for a long time the glacially impounded waters held in the valleys of Oneida, Cowaselon, Chittenango and possibly Limestone creeks. It is not certain whether the low channels between Oneida and Chittenango carried any waters derived from the west of Limestone and Butternut creeks. It is probable however that the low channels west of Chittenango carried in addition to the local waters the eastward drainage of the vast Lake Warren, which then occupied as much of the basins of Ontario, Erie and Huron as the ice sheet had then deserted.

Work in completion of channel investigation

The channel phenomena in the extreme limits of the territory, east and west, remain unstudied. In the area between Rome, Utica and Clinton must lie the easternmost scourways of the entire series. These must have carried to their destination in the Mohawk the waters which cut the channels on Eaton hill, and at least the higher ones on West Stockbridge, Cranson and Eagle hills.[1]

West of Syracuse and reaching past Rochester to the west side of the Genesee valley are capacious channels which are probably later in time than those already described. It is the intention of the writer to make these two sets of undescribed channels the subject of another paper. Thereafter it will be in order to make a summation of all the data in a single writing.

[1] *See* former report, p. 123, 124. Since the above was written the author has examined the Clinton–Utica district and has mapped high-level channels cutting the north slopes of the ridges west and east of Clinton and southwest and southeast of Utica; thus extending the series of high channels eastward into the Mohawk valley. These are roughly indicated on plate 7.

FIELD WORK DURING 1901 IN THE CRETACEOUS BEDS OF LONG ISLAND

BY ARTHUR HOLLICK

The probability that Cretaceous strata underlie the surface of Long Island to a greater or less extent, was conceded by nearly all the early geologists who studied the stratigraphy of the coastal plain in the vicinity. The general trend of the known Cretaceous strata in New Jersey, and the lithologic similarity between the plastic clays of that state and certain exposures of clays on the north shore of Long island justified the assumption that they were probably of the same geologic age, but paleontologic evidence was lacking.

As early as 1871 a few fossil leaf impressions had been discovered in sandstone boulders in the drift at Williamsburg,[1] but they were not recognized as Cretaceous till many years afterward. Subsequently similar remains were found at Glencove, Sea Cliff, Lloyd neck, Eaton neck, Center island and elsewhere and also a few in the clays at Cold Spring, Northport and Glencove, most of which proved to be well known Cretaceous species. These may be found described in several papers by the writer, together with their accompanying conditions and the history of the events which finally resulted in the determination of their identity and significance.[2]

During the month of June 1901 several days were spent in the vicinity of Glencove for the purpose of collecting. A considerable number of specimens were obtained, some as loose material scattered along the beach, but most of them from layers of red shale in connection with the clay outcrop on the

---

[1] N. Y. Lyc. Nat. Hist. Proc. ser. 1. 1871. p. 149, 150.

[2] 1 Preliminary Contribution to Our Knowledge of the Cretaceous Formation on Long Island and Eastward. N. Y. Acad. Sci. Trans. May 1893. 12:222-37, pl. 5-7.

2 Additions to the Paleobotany of the Cretaceous Formation on Long Island. Torrey Bot. Club. Bul. Feb. 1894. 21:49-65, pl. 174-80.

3 Some Further Notes on the Geology of the North Shore of Long Island. N. Y. Acad. Sci. Trans. Jan. 1894. 13:122-29.

4 Geological Notes: Long Island and Block Island. N. Y. Acad. Sci. Trans. Dec. 1896. 16:9-18.

shore of Hempstead harbor, about a mile west of the Glencove landing. This shale is unquestionably a phase of the clay, probably a result of hardening, due to oxidation of iron, and part of the loose material on the beach represents the same, which has been washed out by the waves. Other specimens represent material that has come from the adjacent bluffs, where it occurs as drift boulders, in connection with other morainal material.

In the list of accessions all the specimens noted from Glencove were collected under one or another of the above conditions.

SPERMATOPHYTA

Gymnospermae

Dammara borealis Heer, Fl. Foss. Arct. v. 6, Abth. 2, p. 54, pl. 37, fig. 5.

Glencove N. Y.

Angiospermae

Monocotyledones

Serenopsis kempii Hollick, Torrey Bot. Club. Bul. 20:169, pl. 149.

Glencove N. Y.

Fragments of monocotyledons of uncertain affinities

Glencove N. Y.

Dicotyledones

Juglans arctica Heer (?), Fl. Foss. Arct. v. 6, Abth. 2, p. 71, pl. 40, fig. 2.

Glencove N. Y.

Salix inaequalis Newb., Fl. Amboy Clays, p. 67, pl. 16, fig. 1, 4, 6; pl. 17, fig. 2–7.

Glencove N. Y.

Ficus willisiana Hollick, Torrey Bot. Club. Bul. 21:52, pl. 176, fig. 2, 5.

Glencove N. Y.

Magnolia auriculata Newb., Fl. Amboy Clays, p. 75, pl. 41, fig. 13; pl. 58, fig. 1–11.

Glencove N. Y.

Magnolia capellini Heer, Phyll. Crét. Neb. p. 21, pl. 3, fig. 5, 6.

Glencove and Center island, Oyster Bay N. Y.

Magnolia glaucoides Newb. (?), Fl. Amboy Clays, p. 74, pl. 57, fig. 1–4.

Glencove N. Y.

Magnolia isbergiana Heer (?) Fl. Foss. Arct. v. 6, Abth. 2, p. 91, pl. 36, fig. 3.

Glencove N. Y.

Magnolia longifolia Newb., Fl. Amboy Clays, p. 76, pl. 55, fig. 3, 5; pl. 56, fig. 1–4.

Glencove N. Y.

Magnolia longipes Newb., Fl. Amboy Clays, p. 76, pl. 54, fig. 1–3.

Glencove N. Y.

Magnolia speciosa Heer, Neue Denkschr. Schw. Gesel. 23:20, pl. 6, fig. 1; pl. 9, fig. 2; pl. 10, fig. 1.

Glencove and Center island, Oyster Bay N. Y.

Liriodendropsis simplex Newb., Fl. Amboy Clays, p. 83, pl. 19, fig. 2, 3; pl. 53, fig. 1–4, 7.

Glencove N. Y.

Menispermites brysoniana Hollick, Torrey Bot. Club. Bul. 21:59, pl. 180, fig. 10 (counterpart of type).

Glencove N. Y.

Cinnamomum intermedium Newb., Fl. Amboy Clays, p. 89, pl. 29, fig. 1–8, 10.

Glencove N. Y.

Cinnamomum sezannense Wat., Pl. Foss. Bassin Paris, p. 175, pl. 50, fig. 2.

Seacliff N. Y.

Leguminosites convolutus Lesq. (?), Fl. Dak. Gr. p. 151, pl. 44, fig. 4.

Glencove N. Y.

Paliurus integrifolius Hollick, Torrey Bot. Club Bul. Feb. 1894. 21: 57, pl. 177, fig. 5, 8, 12 (counterpart of type).

Glencove N. Y.

Aralia sp. ? (probably *rotundiloba* Newb., Fl. Amboy Clays, p. 118, pl. 28, fig. 5; pl. 36, fig. 9.)

Glencove N. Y.

Diospyros primaeva Heer, Phyll. Crét. Neb., p. 19, pl. 1, fig. 6, 7.

Glencove N. Y.

Viburnum integrifolium Newb. (?), Fl. Amboy Clays, p. 125, pl. 41, fig. 1.

Glencove N. Y.

REMAINS OF UNCERTAIN BOTANICAL AFFINITIES

Tricalycites papyraceus Newb., Fl. Amboy Clays, p. 132, pl. 46, fig. 30–38.

Glencove N. Y.

Fragments of vegetation, undetermined

Glencove N. Y.

USES OF PEAT AND ITS OCCURRENCE IN NEW YORK

BY

HEINRICH RIES

CONTENTS

USES OF PEAT AND ITS OCCURRENCE IN NEW YORK STATE

The uses of peat are treated in considerably greater detail in this paper than may seem to be warranted by the known occurrence of the material in this State. Still this seems desirable, for few people have a true conception of the availability of this material for other than agricultural purposes. In north temperate regions, where proper climatic conditions exist, peat of good quality is frequently found, and where fuel is both high and scarce this material is in demand.

It is but natural that, with the extended immigration into this country, some of the newcomers should notice the peat of our swamps, and its resemblance to the material of Europe. This fact has no doubt stimulated many to investigate the possibilities of our American peat without always having a true idea of the requirements of the case or the exact nature of the raw material.

A piece of dried muck may appear to burn as freely as good peat, and yet, when its calorific power or chemical composition is actually tested, a material difference is manifest.

Origin and nature of peat

Peat is a dark brown or black, often fibrous mass formed by the accumulation and decay of vegetable matter (specially moss) under water.

Such accumulations may occur in any region where the drainage is retarded, giving rise to the formation of lakes, often of shallow character, which, by a filling process described below, are converted into swamps.

Such swamps may originate in several different ways, forming what are known respectively as terrace, delta, or lake swamps.

Terrace swamps are those formed in depressions on the surface of river terraces or flood plains, specially along their outer edge, that is nearest to the valley sides. Many river terraces slope away from the river, thus causing a depressed area on

either side. During periods of flood these lower lying parts of the terrace may become covered with water which remains after the river subsides. Additional water may drain into the depression from the sides of the valley, and, if the terrace is underlain by a clay layer, the drainage of the area will proceed very slowly or be suspended, thus maintaining a pond in which water and moisture-loving plants spring up, resulting in the development of a swamp. Swamps of this type are less numerous than the other two.

Delta swamps are common in many regions where streams heavily laden with sediment enter a lake, for, the speed of the river current being checked at this point, much of the sediment is deposited around its mouth, forming a delta. As the sediment accumulates year after year, the level of the delta is built up, till the water over it is sufficiently shallow to permit the growth of water plants. These serve to catch more sediment, so that the level of the delta is raised high enough to form first a swampy tract and later dry land, which may be overflowed only in springtime, when it receives an additional layer of sediment, but later none at all.

The result of both these kinds of swamp development and filling is to form a rich, black soil, often of considerable depth, and made up of a mixture of decaying plant fragments and mineral matter.

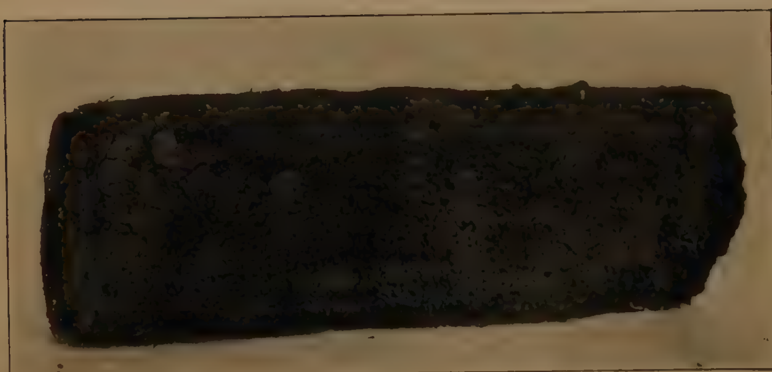
In some cases the filling up of a lake and formation of a swamp may be due almost entirely to the accumulation of vegetable matter. In such cases the streams flowing into the lake carry little or no sediment, as the water supplying the pond may soak into it through the soil from the surrounding slopes, as in the case of Wilmurt lake in the Adirondacks.[1]

Many ponds and lakes in north temperate regions are surrounded by a growth of water-loving plants, and particularly with mosses. As these multiply, they not only send their roots downward into the shallow waters around the edge of the pond,

---

[1]Smyth, C. H. jr. Lake Filling in the Adirondacks. Am. Geologist. 1893. 11:85.

Plate 32



Peat from bog of Cyrus Post, northeast of Cold Spring, Putnam co.

but may also spread toward the center of the lake, forming a mass of floating vegetation. This growth often covers eventually the whole sheet of water, but at the same time thickens, for, as the plants die off in any one place, new ones spring up on their remains. In this way the pond often becomes entirely filled with a spongy mass of matted plant fragments. Such a deposit is known as *peat*, and a section made through a peat bog from top to bottom will show a layer of living plants at the surface, which grow on the clearly outlined stems and roots of dead ones, while below these is a gradual passage into fully formed peat, in which little trace of the original vegetable fibers may be discernible. This lower part is the peat proper, though the name is often broadly used to include the overlying layers.

Peat is very spongy in its character and varies in color from brown to black. It may also show variation in structure, some peat being very fibrous, while other varieties show little fibrous character and are rather cheesy when moist.

The process of peat formation is not one of complete decay, but one of slow oxidation which takes place away from contact with the air. In this change hydrogen, nitrogen and some oxygen pass off, indeed the formation of peat is entirely similar to the first stages in the formation of coal.

As the deposit gains in depth the decomposition of the vegetable matter continues, and this is accompanied by the evolution of gases and a densification of the mass.

This change of vegetable matter into peat is quite different from that taking place when the same material decays under the soil in drained land. The decayed vegetable matter or humus formed under these latter conditions is much darker, sometimes even black,[1] and is insoluble in water, to which it imparts no brown color, while the humus of bog peat is soluble. This insoluble humus is the form most desired by the farmer. The brown humus of bogs can however be rendered insoluble by lime.

[1] Hilgard, E. W. Cal. Exp. Sta. 1892-93. p. 11.

The presence of water is necessary for peat formation, as vegetable matter if exposed to the air alone is completely destroyed. Since most peat is formed from the moss, *sphagnum*, peat bogs are formed only in cold, temperate, humid climates, for the reason that sphagnum does not grow in dry air, and also on account of the fact that vegetable matter ferments more rapidly in moist climates, and is more easily converted into gaseous products.

The reason why sphagnum is a good peat producer is because of its cellular structure, the plant tissues attract and absorb much moisture. Thus a growth of sphagnum may raise the water level above that of the surrounding surface. Also the fibers of sphagnum are tough and make a mass firm for cutting.

The following section of a peat bog is given by R. W. Ells.[1] On the surface there is a growth of stunted tamarack trees. Proceeding downward the following layers are recognized:

1 Green living and growing plants

2 Intermediate zone containing well defined plant remains

3 Lower zone, in which there is very little plant structure remaining

An ultimate chemical analysis of peat shows carbon, hydrogen, oxygen and nitrogen, or the same elements found in the parent plants from which it was formed, but the four elements are present in different amounts. Johnson[2] gives the following analyses, which show the changes that take place in the alteration of sphagnum to peat.

Material	Analyst	Carbon	Hydrogen	Oxygen	Nitrogen
Sphagnum	..Websky...	49.88	6.54	42.42	1.16
Peach wood	Chevandier	49.9	6.1	43.1	.9
Poplar wood	"	50.3	6.3	42.4	1
Oak wood	"	50.6	6	42.1	1.3
Peat, porous, light brown, sphagnum	Websky...	50.86	5.8	42.57	.77
Peat, porous, red brown .	Jaeckel ...	53.51	5.9	40.59	
Peat, heavy, brown	" ...	56.43	5.32	38.25	

[1] Ontario Bureau of Mines. Rep't 1892. p. 195.

[2] Peat and its Uses, p.24.

Material	Analyst	Carbon	Hydrogen	Oxygen	Nitrogen
Peat, dark red brown, well decomposed......	Websky...	59.47	6.52	31.51	2.51
Peat, black, very dense and hard	" ...	59.7	5.7	33.04	1.56
Peat, black, heavy } best for fuel	" ...	59.71	5.27	32.07	2.59
Peat, brown, heavy } best for fuel	" ...	62.54	6.81	29.24	1.41

This table shows similarity but not identity of composition between sphagnum and wood.

It also shows an increase in the percentage of the carbon contents as the material approaches more closely to true peat in composition and character.

According to Johnson the ripest and heaviest peat has 10% to 12% more carbon and 10% to 12% less oxygen than the vegetable matter from which it is produced.

The ultimate composition of the compounds contained in peat is given by Johnson (p. 25), as follows:

	Carbon	Hydrogen	Oxygen
Ulmic acid	67.1	4.2	28.7
Humic acid	61.1	4.3	34.6
Crenic acid....................	56.47	2.74	40.78
Apocrenic acid.................	45.7	4.8	49.5

The ash of peat, representing the mineral matter contained in it, varies much in composition. It may be chiefly silicious, or again lime may predominate. Some peats have been found to be high in sulfate of iron, and it is stated by Johnson that in some cases they contained sufficient to make its extraction profitable. These are known as vitriol peats.

The bases found in the ash may have been combined with the organic acids.

The compounds given off during the decomposition of vegetable matter are carbonic acid gas, marsh gas, nitrogen and water.

Websky found in the gas from a peat bed (Johnson, p. 27):

CO_2	2.97
CH_4	43.36
N	53.67

Analyses of peat from different localities will naturally show a considerable variation, specially in the mineral contents or insoluble matter, which they may contain, but this is easily understood when we consider the origin of peat. Many ponds are fed by streams which are muddy and therefore carry a large amount of sediment in suspension, while other streams entering a pond where peat is forming may be quite clear. The quantity of mineral matter, such as sand, silt or clay, which peat may contain is very variable, and materially affects its uses. Peat containing a high percentage of mineral matter is usually spoken of as *muck*. When peat contains little mineral matter, its fuel value is important, but when much is present then it is of greater value agriculturally. The plant species which formed the peat, also influences the length and toughness of the peat fibers. But these questions will be discussed in more detail later.

The percentage of mineral matter in peat may vary from 1% to 30%. For purposes other than agricultural it should not exceed 7% or 8%. The average composition[1] after deducting the mineral residue and recalculating is: carbon 52% to 56%, hydrogen 4.7% to 7.4 %, oxygen 28% to 39%, nitrogen 1.5% to 3%. Even in the ash of peat there may be considerable chemical variation. Johnson[2], gives the following analyses of peat ashes; 1 being from Poquonnock Ct., 2 from Colebrook Ct., and 3 from Guilford Ct.

	1	2	3
Potash	.69	.8	3.46
Soda	.58	....	trace
Lime	40.52	35.59	6.6
Magnesia	6.06	4.92	1.05
Ferric oxid and alumina	5.17	9.08	15.59
Phosphoric acid	.5	.77	1.55
Sulfuric acid	5.52	10.41	4.04
Chlorin	.15	.43	.7
Soluble silica	8.23	1.4	
Carbonic acid	19.6	22.88	67.01
Sand	12.11	15.04	

[1] Ontario Bureau of Mines. Rep't. 1891. p. 181.

[2] Peat and its Uses, p. 24.

The same author also gives the following minimum, maximum, and average percentages in peat ashes drawn from various sources:[1]

	Minimum	Maximum	Average
Potash	.05	3.64	.89
Soda	....	5.73	.83
Lime	4.72	58.38	24
Magnesia	....	24.39	3.2
Alumina	.9	20.5	5.78
Ferric oxid	....	73.33	18.7
Sulfuric acid	....	37.4	7.5
Chlorin	....	6.5	.6
Phosphoric acid	....	6.29	2.56
Sand	.99	56.97	25.5

Lime is nearly always found in peat ash, and like sand may at times be present in considerable quantity.

All the substances found in the ash of peat are likewise found in that of sphagnum, as seen by the following analysis:[2]

Potash	17.2
Soda	8.3
Lime	11.8
Magnesia	6.7
Sulfuric acid	6.5
Chlorin	6.2
Phosphoric acid	6.7

The following table gives the chemical composition of peat from different localities.

Kane[3] gives the following analyses of peat samples taken from the top and bottom of a bog at Phillipsburg N. J.

	Sp. gr.	Carbon	Hydrogen	Oxygen	Nitrogen	Ash
Surface peat....	.405	57.53	6.83	32.23	1.42	1.9
Bottom peat....	.669	58.48	5.9	31.47	.85	3.3

[1] Peat and its Uses, p. 48.

[2] Johnson. Peat and its Uses, p. 49.

[3] Mineral Industry, 2:490.

The slight variation in ash does not necessarily indicate anything, for even in the same bog the ash percentage may show differences.

Freshly dug peat may contain from 30% to 80% of moisture, depending on the dryness of the bog, and some deposits may be so wet as to need artificial draining before the material can be extracted.

While most peat is formed by the accumulation of mosses, still it sometimes results from the growth and decay of other plants. Koller[1] states that practically all plants except fungi may form it, but that the bog mosses are the most important as owing to their spongy nature they tend to produce a high water level in the pond or swamp. Indeed, on this account a sphagnum bog may often raise the water level above that of the surrounding country.

---

[1] Die Torfindustrie. Leipzig 1898. p. 5.

Chemical composition of peat

SOURCE	Org.	H_2O	Fe_2O_3 and Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	CO_2	SiO_2	Cl	Ins.	Authority
California														
Mowry's sta. Ala. co.	67.16	1.44	......	......	.....	.....	.....	.41	.....	....	......	....	15.4	....
Michigan														
Meare near Bridgewater	97.78	.....	.536	$CaCO_3$ .855	.144	.131	.065	.053	.051	....	.403	....	.....	Mich. Agric. Rep't. 1865. p. 208
New Jersey														
Black brook meadows, Columbia turnpike, Morris co.	65.61	16.16	3.19	3.86	.37	.31	.....	.93	.89	.09	8.64	....	.....	Geol. of New Jersey. 1868. p. 481
Peat cut for fuel at Columbia, Morris co., 3 feet below surface	66.87	15.15	3.97	3.17	.39	.27	.....	.1	2.46	....	7.63	....	.....	Geol. of New Jersey. 1868. p. 481
Allandale bog in Bergen co.	83.8	11.7	.42	1.46	.17	.08	.....	.05	.74	.04	1.07	....	.....	Geol. of New Jersey. 1868. p. 481
Beavertown, Morris co.	69.8	16.8	2.92	3.34	.27	.02	.....	.19	.76	.43	5.36	....	.....	Geol. of New Jersey. 1868. p. 481
C. L. Willitts, Haddonfield, Camden co., compact, well formed	57.1	11.6	12.02	.14	.....	.....	.....	.27	.21	....	18.59	....	.....	Geol. of New Jersey. 1868. p. 482
C. L. Willitts, Haddonfield, Camden co., fibrous, very light	34.8	7.1	5.26	.39	.14	.07		.2	.18	....	51.88	....	.....	Geol. of New Jersey. 1868. p. 482

Chemical composition of peat (*concluded*)

SOURCE	Org.	H_2O	Fe_2O_3 and Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	CO_2	SiO_2	Cl	Ins.	Authority
C. Albertson, Haddonfield, Camden co., near surface	52.8	9.2	5.2	.3	.42	.....	.....	.22	.12	....	31.35	....	.....	Geol. of New Jersey. 1868. p. 483
C. Albertson, Haddonfield, Camden co., bottom same	25.4	5.6	6.02	.39	.3	.33	.....	....	.33	....	61.93	....	.....	Geol. of New Jersey. 1868. p. 483
Ohio														
J. F. Brooks, Salem..........	.....	91.31	Fe_2O_3 .33	[a]1.24	.....	1.26		....	.....	....	5.86	....	.....	Ohio Agric. Exp. Sta. Rep't. 5:281
O. C. Booringer, Brimfield....	.....	85.99	Fe_2O_3 1.99	[a].54	[a].09	.....	.....	....	.....	....	11.04	....	.....	Ohio Agric. Exp. Sta. Rep't. 6:269
D. C. Anderson, Frankfort, Ross co..................	.....	73.38	Fe_2O_3	[a]5.47	[a].44	.....	.....	....	.....	....	16.47	....	.....	Ohio Agric. Exp. Sta. Rep't. 6:269
Wisconsin														
Peat soil														
1st foot..................	75.81	.....	......	......	.....	.09	.....	.3	.....	....	17.8	....	.....	
2d and 3d feet.............	10.09	.....	......	.34	.....	.07	.....	.03	.....	....	92.08	....	.....	Wis. Agric. Exp. Sta. 13th rep't. p. 304
Baraboo														
1st foot..................	84.28	.....	......	2.16	.....	.11	.....	.28	.....	....	8.68	....	.....	....
2d and 3d feet.............	92	.....	......	1.5	.....	.04	.....	.1	.....	....	5.39	....	.....	....

[a] Determined as carbonate.

Some plants, like vaccinium, grow so thick that they hinder evaporation of the water from the surface, thus raising its level and producing favorable conditions for peat accumulation. Where peaty deposits occur in New York State, ferns also take part in the peat growth.

The process of peat formation may begin as soon as the plant is covered by water, but the rate at which peat forms, depends on the plant species and climate.

The average rate of growth given by many is from 2 to 4 inches a year. Percy[1] records an instance of 15 feet growth in 30 years. Koller[2] states that in some bogs peat has been found to increase in thickness at the rate of 75 centimeters in a hundred years, while at other points under specially favorable conditions the same thickness was attained in 30 to 50 years. In still other localities a growth of 2 meters in 70 years has been recorded. In the valley of Somme[3] three feet of peat accumulated in about 40 years; and near Hanover Ger. 4 to 6 feet in the same length of time. Fully formed peat represents about one quarter of the original vegetable tissue from which it has been derived.[4]

Peat deposits are found chiefly in north temperate climates, specially in moist ones. Many thousand acres of the north German plain are underlain by deposits of peat, while in Ireland alone it is estimated that there are 1,576,000 acres of flat bog and 1,254,000 acres of mountain bog. Russia is said to have 67,000 square miles of peat land, and there are also several million acres in Norway and Sweden, while extensive deposits are not lacking in France and Holland.[5] Peat bogs are known in the United States and Canada. While those of the former are not as extensive as European ones, still deposits are found in nearly all of the northern states. They are common in New York, Pennsylvania, Michigan, Wisconsin and Minnesota.

[1] Fuels, p. 201.
[2] Die Torfindustrie, p. 11.
[3] Ontario Bureau of Mines. Rep't. 1891. p. 181.
[4] Mineral Industry, 7:191.
[5] Mineral Industry, 2:490.

Mining of peat

Where peat is to be used for purposes which are not agricultural, some profitable and rapid means of extracting the material becomes necessary.

If the bog is sufficiently dry, the peat can be dug in blocks and stacked up to air-dry as much as possible. When a spade is used to dig the peat, one of special form is employed, consisting of a long, narrow blade, which has a tongue at right angles to it on one edge. This is known as a *slane* in Ireland, and as a *peat-spade* in Scotland.

The bog is usually drained by a series of ditches before the digging commences.

Where the bogs are worked on a large scale, it is usually found desirable to use some form of cutter or excavator, drawn by horses.[1]

In some bogs there is such a large quantity of water, that attempts have been made to collect the peat with dredges set on floating scows, and then extract the water from it by screening, pressing, or drying. In some cases the dredged mass, which comes up as thin mud, is discharged on land, in a thick layer, and this when dry, by the draining off of the water, is cut up into blocks. This process was patented in Canada in 1864 by a Mr Hodges.[2]

The writer has also been informed that a similar process was tried near Fishkill village and also north of Syracuse about the same date.

Uses of peat

It is not unnatural to expect that many applications have been found for peat, for, being a common material in most northern countries, it is noticed by many people, and inquiries made concerning its possible value.

Peat for fuel. This is perhaps the best known use to which peat is put. Its value for this purpose depends on the density,

[1] A number of these are described by Koller in *Die Torfindustrie*, p. 33 *et seq.*

[2] Mineral Industry, 2:492.

dryness, coherence, and purity of the peat. In some countries, notably Ireland and Germany, the peat is dug, dried and then used, but, while cheap when employed in this manner, still it lacks heating power, for it is not only porous, but even when air-dried may still contain as much as 25% or 30% of water. Peat of this character burns very freely.

For developing the maximum calorific power therefore it is not only necessary to dry the peat thoroughly, but also to compress it into some dense and more solid form. Pressure alone is not sufficient to drive out all the moisture, nor has it been found practicable to dry the peat in bulk, and therefore a preliminary pulverization is always necessary.

While experiments carried out on a working scale have shown that, when properly treated, peat will develop a good calorific power, still it can not compete successfully with bituminous coal in those countries where there is an abundance of the last mentioned material.

P. R. Bjorling[1] refers to a peat which was used for fuel, and contained from 75% to 85% of water in its raw condition. This was reduced to 5% to 15% by air-drying, and in that condition contained from 5% to 15% of ash. The composition varied between 50% and 66% carbon; 4.7% to 7.4% hydrogen; 28% to 39% oxygen; and 1.3% to 3% nitrogen. In the air-dried condition the calorific value was 3000–3500 units, or, when dried at 100° C, it was 5200 units.

Experiments which have been made to test the heating effect of raw and prepared peat as compared with coal, indicated that the number of pounds of water heated from 0 to 100° C, by one pound of peat varies from 18 to 62.[2]

The heating power of peat can be determined by means of a calorimeter. The principle of this consists in determining the number of degrees temperature to which a given quantity of water can be raised by the heat given off by a certain amount of peat in burning. For such a test a number of different calorim-

[1] Colliery Guardian, 80:1127, 1183, 1294; 81:21.

[2] Mineral Industry, 2:492.

eters have been used, but one of very convenient and simple form is somewhat as follows. It consists of a cylinder of sheet iron which is jacketed with wooden staves. Inside of this there is a spiral sheet copper tube which carries off the smoke from the little fireplace, which is totally inclosed by double walls of tin. The covering of the sheet iron cylinder already mentioned has four openings, one for the smoke pipe leading from the spiral tube, another one for the insertion of the thermometer, a third for inserting a stirrer, and a fourth for filling the cylinder.

The fireplace has a grating with a small ash pit beneath it, and these two have separate doors. The upper door, leading into the fireplace, proper, has an opening for the admission of air or draft, and a second for inserting a pipe leading from the bellows. At one side of the cylinder is a stopcock for drawing off the water. In using the apparatus the cylinder is filled to a distance of 4 cm from the top with cold water, the exact volume of which is known. The temperature of this water is determined before commencing the experiment. A weighed amount of the peat is then placed on the hearth, set on fire, and the door of the fireplace closed. Air is then pumped into the hearth by means of the bellows. From time to time more fuel is added. At the end of the experiment a note is made of the time which the test has taken, the temperature of the water and the quantity of the material burned. The percentage of ash is also determined. Knowing then the amount which the temperature of the water has been raised, the weight of the water used and the amount of the fuel consumed, we can figure out the calorific power of the peat. In order to obtain very exact results, a correction should perhaps be made for the amount of heat absorbed by the metal cylinder holding the water, though the loss of heat by radiation through the walls of the cylinder is reduced to the minimum by having it jacketed with wood, as before mentioned. The amount of heat lost by absorption into the metal can be determined by muitiplying the weight of the metal cylinder by

the specific heat of the metal of the same, adding this product to the weight of water.

Thurston in speaking of peat says: "Dried in air, peat, like the lignites, retains moisture persistently, and is usually found to contain 30% after drying. A pound of charcoal and 1.66 pounds of peat have nearly the same heating value. When used for fuel, it is usually cut from the bog with sharp spades, ground up in a special machine, and then spread out in the sun and air to dry. It is frequently compressed by machinery till its density approaches that of the lighter fuels, and it is then used in blocks of convenient size. Its specific gravity is about .5."

Johnson[1] states that in using peat as fuel regard must be had to its shape and bulk. Flat blocks are apt to lie closely together in the fire and obstruct the draft. A fireplace constructed properly for burning them should be shallow, not admitting of more than two or three layers being superimposed. According to the bulkiness of the peat, the fireplace should be roomy as regards length and breadth. Fibrous and easily crumbling peat is usually burned on a hearth, either in stoves or open fireplaces. Dense peat burns best on a grate, the bars of which should be thin and near together, so that the air may have access to every part of the fuel. The denser and tougher the peat, the better is its heating power.

Pressed peat. It has sometimes been found desirable in the use of peat fuel to press the material into bricks, instead of using it in the porous condition in which it is found in nature. The advantages which pressed peat possesses are, that a given volume of the material has much greater heating power; the blocks of the material dry out very rapidly and do not absorb much moisture; in the transportation a given quantity of peat in the present form takes up much less room than the unconsolidated material, and furthermore, not only stands the transportation better, but is stronger and can therefore be built or piled up much higher on the freight cars. It requires much less

[1] Peat and its Uses, p. 102.

space in storage; and in the manufacture of the material much less drying space is required.

Wherever peat is extensively employed for fuel, the air-dried material is usually compressed into briquets. This has been used in Sweden for some time, and has also been tried in Germany and Canada.

Various methods are used in the preliminary treatment of the material. In some experiments recently made at the Royal Testing Station at Berlin[1] a method was used which had been devised by engineer Strauber. The peat used had the following composition.

Fixed carbon	45.14
Hydrogen	4.54
Oxygen	29.34
Ash	9.09

Its thermal value was 3806 calories, which is said to equal brown coal. While the details of the process are not given out, it is said that it is possible to reduce the water contents to about 12% by the application of the proper amount of heat.

In working the peat, the material is pulverized in specially contrived machinery, and fibers, roots and other impurities eliminated. The water is removed by compression, and the cleansed and pulverized material pressed into molds by automatic machinery. Hopes are entertained that the peat briquets made by this new process will replace the lignite so much used in Germany.

At a Danish works[2] the peat is dredged from a scow, on which there is also located a pulper or pug mill. The peat is dug by hand, and shoveled into the pulper together with water. When mixed, it is discharged automatically into dump cars, which take the material to the molding and drying floors. By this process, it is claimed, one man can dig a ton of peat (calculated dry) per hour, or 10 tons per day. On this continent a peat fuel plant is

[1] Consular Reports. Nov. 1901. 67:254.

[2] Mineral Industry, 7:191.

in operation near Welland Ont. It is operated by the Canadian Peat Fuel Co. of Toronto, which has a peat bog of about 5000 acres.[1]

At the Trent Valley Peat Fuel Works, Kirkfield Can., the peat is raised by means of a dredge and conveyed to the works, where it is pressed and then dried in a sloping cylinder 5 feet in diameter and 30 feet long. The yield is 3 tons of dried peat per hour, and the product, which has 12% moisture, is compressed into cylinders 1½ by 1½ inches.

One form of drying chamber which is in use near St Petersburg, Russia, consists of a series of cast iron trays, placed one above the other, and heated by exhaust steam; the pulp is conveyed along these trays, being stirred all the while, and is then delivered finally to the pressing machines.[2]

Peat coal. By heating peat to about 200° C, or till combustible gases begin to come off, peat coal is formed.[3] In one patented process known as a Mrs Angel's, the peat is placed in closed vessels without gas exit and burned at comparatively low temperature, whereby the products of distillation are retained in the coal. The peat used should be previously freed from the larger part of its moisture. The apparatus is heated to a temperature of 50° to 400° during 1 to 6 hours. The coal is said to then have a metallic luster and to be hard and free from soot and compare favorably with bituminous coal. The following table, taken from a report by Professor Klasson[4] shows the average composition of different coals and peat, together with the mean calorific value of the absolute dry and ash-free fuel, and the average percentage of moisture in its dried state.

	Carbon	Hydrogen	Oxygen	Sulfur	Nitr.	Calories	Moist.
Wood........	52	6.2	41.7	..	.1	49	20
Peat.........	58	5.7	35	..	1.2	57	22
Brown coal...	66	4.6	28	..	1	60	25

[1] Ontario Bureau of Mines. Rep't. 1896. p. 188.
[2] Bach, A. Inst. Civ. Eng. Proc. 1900. p. 147.
[3] Mineral Industry, 7:191.
[4] Jubilee number for 1896 of *Tecknisk Tidskift*.

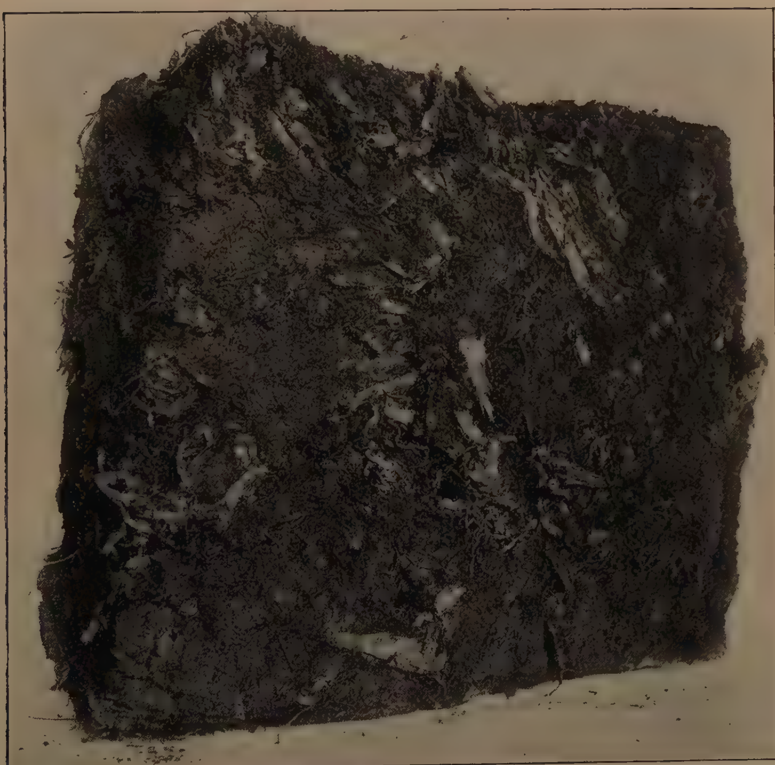
	Carbon	Hydrogen	Oxygen	Sulfur	Nitr.	Calories	Moist-
Swedish coal..	78	5.1	14.8	.8	1.3	75	13.5
English steam coal.......	81	5.2	11.5	1	1.3	80	7.6
English gas coal.......	87	5.2	5.5	1	1.3	87	1.7
English coke coal.......	87	4.9	4.1	1	1	86	1.4
Welsh anthracite	91	3.5	3.5	1	1	86	2

It is said that, while the Swedish committee expressed a favorable opinion as to the value of peat fuels, namely peat briquets, peat coal, and peat dust, still the peat coal was pronounced to be economically short of what it was claimed to be, for it was found that 16% of the heat value of the peat was lost in the process of carbonization, and, furthermore, that the process of manufacture was so expensive that peat coal could not compete with other coal. Attempts have been made to utilize peat charcoal for iron manufacture, but one great objection is its low strength and also the occasional presence of phosphates.

Moss litter. This term is applied to the material consisting of the matted roots and stems of dead mosses, which have decayed but little or not at all (pl. 33). It forms a layer between the growing moss on the surface and the fully formed peat underneath, and may often be several feet in thickness. On account of its high absorptive power for gases and liquids, it has found wide application as a deodorizer and disinfectant. The following partial analyses, taken from bulletin 49, *Fertilizers as Sold*, by T. McFarlane, Laboratory Internal Revenue department, Ottawa, show the composition of the material.

	Moisture	Ash	Nitrogen
Light colored moss, Caledonia Springs	10	1.6	2.95
Dark colored moss, same place.......	11.6	2.7	2.23
Peat, same place....................	10.95	3.9	2.94
Surface moss, Mer Bleu, at Eastman's.	10.85	2.8	.71
Moss litter, Welland Co., bog........	3.85	4.7	1.51
Peat under preceding................	5.3	4.85	1.41

Plate 33



Moss litter from a peat bog

The use of moss litter has been well known for a number of years, specially in Sweden. In Germany the material obtained from the high moors has also yielded excellent results. The sphagnum predominates as long as there is a layer of living plants on the surface, but when it dies, heath plants, such as *Cassandra*, *Andromeda* and *Kalmia*, spring up. Sphagnum litter is preferable, as, on account of the great number of empty cells which this plant contains, its absorptive power is high.[1]

The absorptive power of the litter decreases with an increase in the degree of decomposition.

Moss litter is being extracted at but few localities in this country. Among the most important may be mentioned one near Welland Ont., belonging to the Canadian Peat Fuel Co. A description of the deposit and plant may be quoted from the report of the Ontario Bureau of Mines, 1896, p. 186.

The first stage of the operation is to cut the moss into blocks about 18 inches square, which are piled together in rows on the surface of the bog. When the moisture has sufficiently evaporated, the blocks are gathered and wheeled in small cars to the storing sheds. They are then passed through the picking machines, two of which stand side by side. These are provided with heavy revolving cylinders armed with strong teeth, which act upon similar teeth set in the concave surface of the breast against which they work. In the pickers the moss is torn and loosened apart, the object being to separate the fibers rather than to break them. The pickers discharge the moss on to moving carriages, three in number to each machine, ranged above one another, which carry it horizontally through a drying chamber or tunnel 116 feet in length, 8 feet high and 16 feet wide. These carriers travel against a current of hot air drawn through the tunnel by a disk fan revolving at the farther end. The object is to remove the greater part of the moisture remaining in the moss. The heat for this purpose is generated by a furnace situated parallel to the tunnel, whence the hot air is drawn by the suction fan into a mixing chamber. The hot blast, after passing over the moss, emerges laden with moisture into a wooden shaft and so into the outer air. At the end of the tunnel the moss falls into a conveyor, from which it is elevated into a weighing bin or hopper situated above the bailing press or

[1]Jack, E. Ontario Bureau of Mines. Rep't. 1893. p.139.

packer. The hopper works automatically, and, as soon as sufficient weight is received, it deposits its load in the press, which is a machine of peculiar design. In the finished state the litter contains 30% to 33% of moisture, and in this condition it goes into use. It is said to take up liquids more readily in this condition than when the cells of the plant are perfectly dry. The material is shipped to New York, Boston, Brooklyn, Baltimore, Philadelphia, Chicago and other large cities in the United States. It retails in New York for $15 per ton.

Much of the moss litter sold in the United States is also imported from Holland.

Mr McFarland states that the manufacture of moss litter was attempted at Musquash N. B., and is now being produced in Ontario. Dr Laberge of Montreal, who experimented with the latter product, reports that 100 pounds of litter were sufficient for drying 800 pounds of ordinary excreta from privy pits in Montreal, and rendering it entirely inoffensive. A sample of the product remained for days in his office without attracting notice, and indeed it was quite devoid of odor. Its analysis gave the following results.

	Per cent	Pounds per ton	Value per ton
Nitrogen	1.31	26.2 at 13c	$3.41
Phosphoric acid	.9	18 at 5c	.9
Potash	.14	2.8 at 5½c	.15
Water	65.47		
			$4.46

The valuation of ordinary, fresh barnyard manure with 75% of water is about $2 per ton; with 67%, nearly $2.25. Therefore much better results might be expected agriculturally from a moss manure of the composition just described.

Moss litter might also be applied with great advantage in public urinals. When a sample of it was supersaturated with urine and dried and this process repeated several times, no offensive odors were developed. The product on analysis was found to contain 12.41% of nitrogen, which is equal in valuation to $32.26 per ton.

The results obtained in several localities point well towards the successful use of litter as a disinfectant.

At Copenhagen, Denmark, the material has been used by the Copenhagen Milk Supply Co. At this works "each stall is con-

structed with a hollow, lined with cement 3 inches deep, below the level of the floor paving. This is filled with the litter. About an inch is removed daily from the surface, the fresh supply being laid at the manger end, while the supply of the day before is raked from the head to the hinder end. The litter so removed forms an excellent manure. The peat moss litter is delivered in compressed bales of 150 pounds each, but care must be taken that it should be almost free from any moisture in order that it may be able better to absorb all moisture when in use.[1]

Hollman's system of manufacturing moss litter is as follows.[2] The moss peat is cut out of the bog in sods in precisely the same manner as fuel peat. The autumn and early winter are chosen for work so as to allow the moss peat to freeze before drying. It is dried in stacks in the open air. At Carolinenhorst about 6½ acres, 58 inches deep, are cut each season, and yield about 3000 tons of moss litter. The sods when dry are taken to the factory, placed in elevators and carried to a machine called the "*wolf*," which tears them into small fragments. The moss thus produced is passed over sieves to separate the peat dust from the fibrous substance, which forms the litter. It is then put into a press, and with 4 H. P. about 6 cubic feet of loose material is pressed into a space of 2 cubic feet, and then baled.

It is claimed for moss litter that, (1) it affords a drier and healthier bedding for horses and cattle than any other material, (2) that in consequence of its great power of absorbing moisture it binds the valuable portion of the animal excrements and consequently yields the best manure, (3) that it acts as a disinfectant and improves the air of the stable, (4) that a smaller quantity of it is required than would be needed if straw were used.

Moss litter absorbs eight times its weight in urine, while straw takes up only three times.

The smaller particles which are separated, the *torf mull*, are powdered and sell at 1s 3d per cwt. It is said to be used as a disinfectant, as a material for making antiseptic bandages, in absorbing the lye resulting from the treatment of molasses with strontium in sugar factories, as an admixture with salts used in powder, as chemical manure, and as packing material for breakable or perishable goods.

A mixture of peat dust, India rubber and sulfur, has been found to be excellent material for insulating subterranean electric cables.

Pure moss peat powder, free from admixture of grass peat or particles of sand, has been used for some time in the manufac-

[1] Ontario Bureau of Mines. Rep't. 1892. p. 211.
[2] Ibid. p. 214.

ture of gunpowder to replace charcoal. Peat fiber carefully freed from dust is beginning to be used as a material for carpets and other coarse textile fabrics. The fiber is also used as raw material in some paper mills and manufactories of celluloid.[1]

Distillation of peat. M. Miron[2] states that in the distillation of peat at the Montaugier works in France the following products were obtained from 2250 kg. of peat: peat coal 1000 kg., ammonia 15 l., methyl alcohol 25 l., acetic acid 30 l., benzol 15.5 l., illuminating oil 120 l., paraffin 6 kg., tar 65 kg., heavy oil for lubrication 18 l. When only the three principal products were desired, it was possible to obtain per ton of peat, 9 l. of illuminating oil, 4.5 l. of heavy oil, and 1.3 kg. of paraffin.

It was also possible to obtain ethyl alcohol from peat, and this was obtained by adding sulfuric acid at 30° to 35° F.B. to the peat in sufficient amount to obtain with the water in the peat a 2.5% solution of the acid. This is boiled for five hours under pressure at 115° to 120° C. It is then filtered and the solution concentrated and the acid neutralized with milk of lime and calcium carbonate. The solution is cooled to 25° C and allowed to ferment and the ethyl distilled off. In this manner, it is stated one gallon of absolute alcohol can be procured from 215 pounds of peat containing 14% of water. It is also stated that, when this is compared with the best yield of good potatoes (with 20% of starch), which means 1 gallon of alcohol from 111 pounds of potatoes, the result is very encouraging.

Artificial wood. A German patent covers the process of manufacturing artificial wood from peat. This is done by thoroughly mashing and breaking up the fibers into dust and then mixing it up into a pulp, after which it is dried and then mixed with plaster of paris water. This mixture is put into molds under strong pressure, when the mixture is squeezed out, after which it is kiln-dried and then coated with oil. Great durability is claimed for this artificial wood.[3]

---

[1] Marschick–Technische Blätter. ser. 4. 1899. p. 149-66.
[2] La revue technique, Ap. 16, 1898 quoted in Min. Ind. 3:198.
[3] Mineral Industry, 7:191.

Peat fuel for regenerative gas furnaces. The Siemens regenerative gas furnace is claimed to be applicable to peat. Ure (3:526) says that, while 2¼ tons of peat equal one ton of coal in general practice, still, when used in Siemens, it equals 65% Staffordshire coal.

Other uses of peat. Peat charcoal is good as a disinfectant and deodorizer, and also used as a filtering medium for foul water and sewage. The raw peat is said to have good effect on certain soils, supplying much nitrogen and vegetable humus. Peat ashes and peat charcoal also are valuable as manures.

Agricultural uses of peat. Peat has a variable agricultural value, being less desirable the more closely the material approaches purity, for in such a condition it would lack all of the elements of plant food. The best results are consequently obtained from a peat containing appreciable quantities of mineral matter, though here variation in quality occurs, depending on the chemical composition of these insoluble constituents.

Peat of high purity does not produce a productive soil without considerable preliminary work, for, firstly, it may be deficient in mineral matter and, secondly, on account of the high absorptive power of humus, the soil is soaked with water, preventing the aeration of the mass. Deposits of this type are usually prepared for tillage by underdrainage, and burning followed by thorough plowing.

In many instances peat bogs have been nicely adapted to the cultivation of cranberries by putting a layer of sand several inches thick on the surface of the peat swamp.

Where peat deposits contain considerable mineral matter, by drainage and aeration, a soil of high fertility is developed which is specially valuable for the cultivation of celery and onions.

Peat as a fertilizer. Peat is sometimes added to a soil to improve both its chemical and physical properties.

On account of its high absorptive power for water, it increases the moisture of sandy soils if added to them, and, on account of its dark color, it may also add warmth, since it draws the heat. The temperature of a clay soil may be increased 2°

and that of a sandy soil 4° by the addition of peat.[1] The apparent coldness of many peat soils is due to the presence of much water, for they have high absorbent qualities.

Even though appearing absolutely dry, peat may still contain from 10% to 20% of moisture.

Peat also shows considerable affinity for ammonia, absorbing as much as 1.3% under favorable conditions.[2]

Many sandy soils by the addition of humus or peat, form excellent ground for early market gardening.

The addition of peat to heavy clay soils increases their porosity and lightens them.

Peat also promotes the disintegration of mineral matter in the soil, the effect of the humus being that, in contact with certain bases such as alkalis or lime, it absorbs oxygen, and becomes converted into humic acids. So strong is the affinity of this humus for oxygen, that it may even draw it from oxids in the soil, and thus fix the bases.

Marine marsh soils. These form a special type, which is found to some extent along the seashore. They are formed by the accumulation of fine mud in sheltered or quiet waters along the coast. On this mud flat there springs up a growth of eelgrass, which serves to entangle more mud and organic remains, thus raising the general level of the flat, and on this raised surface land grasses and plants spread out, forming a marine marsh.

The task of reclaiming soils of this type is by no means difficult, as has been pointed out in a circular (no. 1) recently issued by the divisions of soils of the Department of Agriculture.

These salt marshes are usually underlain by silt and clay, and may be covered by a foot or so of grass growth. Soils of this type are not usually in need of lime, because they contain more or less shell fragments. If this be lacking, the soil is apt to be too acid, this being either natural or due to the decomposition of organic matter; such sourness may be counteracted by the addition of lime.

[1] Mich. Agric. Rep't. 1886. p. 157.
[2] Johnson. Peat and its Uses, p. 33.

Iron sulfid may also be present, and by its decomposition may yield hydrogen sulfid, soluble ferrous iron compounds, or sulfuric acid, all of which are harmful. The hydrogen sulfid may be corrected by aeration, but the ferrous iron has to be changed by similar treatment, with the addition of lime. Ferrous iron is usually found over small areas only, which yield but slowly to cultivation.

Phosphate of iron or vivianite may be present in these marine marshes, as well as other swamp deposits, and often forms blue specks or spots.

The saline character of these marine marshes also has to be remedied; but, since the sodium chlorid, or common salt, is easily soluble, drainage aided by rainfall soon washes it out of the soil.

The following analyses, give the composition of

1 Mud from tidal flat
2 Subsoil of an outer marsh
3 Subsoil of an inner marsh which was partially drained

} At Oyster Bay N. Y.

	1	2	3
Lime	.43	.31	.41
Potash	.57	.57	.68
Phosphoric acid	.16	.14	.12
Organic	7.18	5.36	10.9
Soluble in H_2O	2.16	2.55	3.56

The soil in each case would contain a much greater quantity of organic matter.

Cattail swamps. In many lakes and rivers of New York State considerable filling is going on, due in part to sediment but more largely to the rank growth of cattails. This produces a mixed deposit, which resembles peat little or not at all, but in some of the older reports seems to have been referred to under this name.

Peat in New York State

True sphagnum peat is not uncommon in the State of New York. Areas underlain by muck, that is impure peat, containing much mineral matter, are also very abundant, and often

form fertile soils. These muck areas are usually found in the depressions, and represent the site of former ponds, which have been filled up by accumulations of vegetable matter and sediment.

Extinct lakes of small size are scattered all over the state, and are located either in closed valleys, natural rock basins, or depressions in the glacial drift. Indeed, these glacial lakelets are extremely abundant, as would be expected in a state so heavily drift-covered. Many of these are only of a few acres in extent, and, while sufficient to supply peat for farming purposes, would not pay to work in case the peat were to be extracted for fuel, gas-making, etc.

Many of the muck areas show a great depth of material (25 feet or more) which is often quite elastic, so that a person standing on the soil can feel the jar of a light buggy passing at a distance of 25 feet. There is also apt to be both horizontal and vertical variation in the character of the material. Where peaty matter exists, it frequently becomes more impure with depth, but, on the other hand, frequent tilling may have developed a loamy soil on the surface, which covers the better peat below.

These muck areas have been referred to by Mather, Vanuxem and Emmons as peat deposits in their reports on the geology of New York State; and it is interesting to quote their remarks as a comparison of early conditions with those now existing.

Mather[1] writes in his report for 1838 that

It (peat) is now coming into use as a fuel, and must, before many years, be extensively employed for this purpose in this part of the country, where coal and wood are so expensive. The marshes of the Hudson river, in New York, Westchester and Putnam counties, that will yield peat, may be estimated at 1000 acres, with a yield of 2000 cords per acre, or 2,000,000 cords. These include those near Sing Sing, Verplanck, Peekskill, Anthony's Nose, Constitution Island, and numerous smaller ones. The peat in most of these marshes, where it was examined, is of inferior quality, fibrous, and contains much earthy matter. That formed in marshes in the interior of those counties is of much better quality, and far superior as an article of fuel.

And later[2] in his report for 1839, he writes:

I would again urge upon our farmers and other citizens the im-

[1]Third Annual Report on Geology of First District, p.74.
[2]Fourth Annual Report on Geology of First District, p.216.

portance of making use of peat for fuel and manure. It is a cheap and valuable article for fuel; and, when properly prepared, it also makes one of the best renovators of the soil.

In referring to the peaty areas, it seems best to treat the State in three parts, viz, southeastern, northern and northeastern, and central and western.

Southeastern New York. Mather and Beck in their reports published in 1841 and 1842, have given a long list of peat-producing localities in the southeastern part of the State, including the following:

[1] Round pond, in the north part of Kinderhook, contains 2000 to 3000 cords.

The marshes and shallows of Kinderhook lake probably contain 20,000 to 30,000 cords.

A small bog between this lake and North Chatham contains perhaps 2 or 3 acres of peat.

In the marsh west of the post road, 1 mile north from Kinderhook, there is said to occur a considerable quantity of peat.

The marsh belonging to Mr Lucas Hoes, 1 mile southwest of Kinderhook, near the post road on the east side, contains about 30 acres, with a mean depth of 6 feet.

Several other localities are said to occur in the valley of Kinderhook creek, between Kinderhook village and Stuyvesant town line.

A peat bog is also said to occur 2 miles northeast of Valatie.

Peat bogs occur in many places in New Lebanon, among which may be mentioned those on Mr Gillett's and the adjoining farms, and on Mr Tilden's.

Another, south of Mr Carpenter's, of 15 acres, and 3 to 12 feet deep.

Another, south of Fitch & Kirby's store, owned by Mr Waite, of about 30 acres.

Peat occurs near the west side of Canaan mountain, around Adgate's pond. The aggregate amount in this township is probably 400,000 cords.

Peat occurs on Rowland Story's farm, $\frac{1}{4}$ mile east of Lafayette Corners, in Milan.

A bog of peat, of 5 or 6 acres, with a depth of 5 or 6 feet, occurs a mile and a half east of Upper Red Hook.

Another between Stormville and Hopewell.

Several bogs between Hopewell and Fishkill appear to be peat bogs. They contain probably an aggregate surface of 40 acres.

[1] Quoted by Leavitt in *Facts about Peat*, p. 124.

A peat bog of 5 or 6 acres is located about 1½ miles from Stormville, on the road to Beekman.

An extensive peat bog extends north from Long pond down the valley of its outlet.

A large body of peat is said to exist on Mr Legget's farm in Ghent.

Peat probably exists in the marsh east of Great Nutten Hook.

Extensive deposits are found a mile or two west of Malden.

Two or three small peat bogs occur in the south part of the town of Ghent. They may contain 10 or 15 acres.

A small marsh of ligneous peat occurs about 1½ miles north of Hillsdale.

There is an extensive peat bog on Lawrence Smith's and the adjoining farms in Amenia. Professor Cassels reports it to have an area of about 150 acres, containing probably 150,000 cords.

He also reports that there is a peat bog 4 miles northeast of Dover on the east side of the creek; another, 1 mile south of the above; another, 1 mile south of the last mentioned; one also 2 miles south of Dover; and one 8 miles south of Dover. These contain an aggregate of probably 75,000 cords.

Extensive peat bogs are found east of Elbow mountain, which lies east and northeast of Dover. They are in the valley through which the road passes from Kline Corners to the Columbia furnace in Kent. The northern one is about ¾ mile long, and 200 yards wide, with an unknown depth. Its depth was measured in several places, and it was generally 5 feet deep within 5 rods of its edge. It was once a lake, now filled with peat. Its mean depth may probably be placed at 9 feet, its area at 60 acres, and its contents at 90,000 cords.

The other bog south of this probably contains 40 acres, with a depth of 6 feet; and its contents may be estimated at 40,000 cords.

Peat is found abundantly in the vicinity of Pine Plains, and some of it is of very good quality. A small bog is observed one mile south of Pine Plains. Cranberry marsh and Cedar swamp, near Stissing pond, are filled with peat. It is rapidly forming in some parts of Stissing pond.

Peat is forming on Woodward's farm, in Copake. In Taghkanick, about a mile and a half or two miles west of Crystler's pond, a peat bog of 30 or 40 acres occurs.

The marsh in the valley of Stissing pond contains a great body of peat; probably 500 acres are underlain by it, 2 yards deep; and its contents may be estimated at 500,000 cords.

In Clinton, 4 miles east of Union Corners, is a peat bog of about 65 acres. It is on the land of Messrs Underwood & Denison, and contains about 60,000 cords.

Another, of nearly 60 acres, in the southeast part of Stanford with a depth of about 6 feet.

Shaw pond and Mud pond, between Stanford and Washington, and Round pond, in Washington, are filling up with peaty matter.

A large peat bog was observed near Patterson, Putnam co.

There is said to be a fine deposit of about 150 acres east of Croton, and about 4 miles southeast from Somers Plains.

Another is in the valley of the Hackensack river, about 2 miles west of Nyack, and contains about 50 acres, with a mean depth of 6 feet.

Professor Cassels reports a peat bog of 40 acres on land of John Snediker, 1 mile southwest of Snediker's Landing, with an average depth of 6 feet of good peat. This peat bog has been wrought for the New York market.

It will be seen from this that swampy tracts are very abundant. In some of these the material is more peaty than in others, but no large areas of true peat seem to exist.

Attempts were made to utilize the peat about 30 years ago in the region east of Fishkill village, it being stated that the peat was dredged from the ponds and then spread out on the shore to dry, after which it was cut up into blocks.

Several areas of muck still remain in this region, but none of them are true peat.

Orange county contains about 40,000 acres of peaty swamps, most prominent among which are the Drowned Lands, lying west of Warwick and covering about 17,000 acres; the Greycourt meadows, underlain by similar material, are also very extensive.

Northern and northeastern New York. This includes the region from Troy northward to the Canada boundary, and westward to Lake Ontario, and is probably a good region in which to search for peat, specially in St Lawrence, Jefferson and Clinton counties.

In Washington county there are according to Leavitt (p. 133) several areas as follows: at the south end of Summit lake in South Argyle, 50 acres; on McNeil's farm in North Greenwich, 25 acres; between Argyle and Hartford, 100 acres; one mile southeast of Greenwich, 70 acres; in Kingsbury township on the Champlain canal, 1000 acres.

To the south of Fort Ann, in the valley of the Hudson river below Fort Edward there are extensive swampy tracts. One approximates 800 to 1000 acres, according to Mr W. H. Norris, and the peat varies from 12 to 40 inches in depth. It was cut through while the ship canal route was being surveyed about 1898. Mr Norris thinks it runs 30% to 40% carbon.

Another deposit is that known as Cedar swamp, northeast of Glens Falls, and said to contain 300 to 400 acres. It varies in depth from 1 foot to 20 feet.

Still another of about 50 acres lies 3 miles south of Fort Ann.

One of about 10 acres is southwest of Glens Falls. Another is 4 miles north of it.

Some of these, being along streams, are covered during periods of overflow, and much mineral matter becomes mixed in with the organic accumulations.

Mr F. W. Wait, of Glens Falls, states that some 20 years ago the Albany Peat Works established a plant, and operated it for some years in the swamp between Glens Falls and French Mountain, on the road leading to Lake George. Work was abandoned after a time, however.

About 10 years before this, Judge E. H. Rosecrans produced peat from what is known as Rosecrans swamp, northeast of Glens Falls, but this likewise was discontinued.

Much lake-filling is in progress in Essex county, producing many swampy meadows, which may yield impure peat.

Thus a long swampy tract extends from Hammond pond, in North Hudson township, to Overshot and Dudley ponds in Crown Point township; another one is in the valley of Desolate brook in the southeast corner of Essex county. A considerable chain of swamps is also seen in Minerva township.

In Clinton county there are numerous swampy tracts, none of them of great extent however. Mather states that large quantities exist in the western part of Champlain township.

On the topographic sheets a number of swampy tracts are indicated thus: north of Plattsburg along Dead creek, and south of Woodruff pond along the Delaware and Hudson railroad,

2 miles north of East Beekmantown, and northward toward Champlain. Within a radius of 3 miles from the village of Moores, specially to the north, there are many swampy tracts, but, while some are covered with a growth of moss, and others utilized for cranberries, still little or no peat occurs so far as could be ascertained. Southwest of Scioto in Chazy township is another extensive swampy tract.

Peat is also said to occur in the "Great marsh" in Duane, Belmont and Malone townships. Near Duane on lot 51, township 12, is said to be an area of 15 acres of peat.

In the Northeastern corner of Franklin county, the Saranac river is bordered by swampy meadows, and others occur in that vicinity.

Along the line of the New York Central Railroad, Adirondack branch, there are many vlies, notably south of Horseshoe, and also along the north branch of Moose river. Some of these show peaty matter, but are often of little thickness, being underlain at no great depth by sand.

Many small swamps are found in Herkimer county, as along Lime Kiln creek.

Along Lake Ontario, between Caldwell hill and North landing, Jefferson co. is a large marsh, and many of the landlocked bays on the same shore, as near Selkirk, Oswego co. are filling up, but it seems doubtful whether they will in time yield even impure peat.

Many boggy areas exist in St Lawrence, Jefferson and Lewis counties, but none have been utilized to any extent, except for farming. An area of 100 to 150 acres in extent is located about $1\frac{1}{4}$ miles from Natural Bridge; another of about 75 acres occurs near Antwerp.

Lake-filling is going on at many points in the Adirondack region;[1] and yet very little peat seems to have been formed, for the streams flowing into the lakes often carry much sediment, and plants other than mosses usually fill up the lake.

---

[1] *See* Smyth, C. H. jr. American Geologist. 1893. 11:85.

An analysis made by the writer of a peat sample from the property of Charles Doty near Ilion gave:

Moisture	19
Volatile hydrocarbons	62.6
Fixed carbon	6
Ash	11.8
	99.4

Central and western New York. This area includes several large swamps, which are however either underlain by peat or covered with a thick growth of cattails and grasses.

The production of good peat in areas of the last type is interfered with from two causes. In the first place, the water level does not remain constant, thereby interfering with the continued accumulation and decay of vegetable matter out of contact with the air. Secondly, the fact that these swamps are traversed by streams insures the deposition of much mud with the vegetable matter.

The largest swamp area in this district is the Montezuma marshes, located at the north end of Cayuga lake. These cover an area about 8 miles long and 3 miles wide, which is filled in most places by a thick growth of cattails and aquatic weeds, while setting through it is a rather rapid current bearing much sediment in suspension, a large amount of which becomes entangled in the plant stems. Some day when the marsh becomes filled, the land thus formed will be valuable for farming purposes, but it is of no value as a source of peat.

The formation of lakes in a drift-covered region is well seen in the drumlin area of north Cayuga county in the region around Fairhaven, for the interspaces between the hills are liberally dotted with ponds showing all stages of filling by vegetable growth. This same region extends westward into Wayne county and eastward into Oswego county. In the latter, additional marshy tracts are found northeast of Hannibal as well as in the valley of Mud pond, north of North Hannibal.

An area similar to the Montezuma marshes is that known as Oak Orchard swamp, which about fills a quadrangle whose cor-

Plate 34

W. W. Rowlee, photo.

View across Montezuma marshes at foot of Cayuga lake

W. W. Rowlee, photo.

Peat bog locally called the lily marsh, New Haven, Oswego co.

Plate 36

W. W. Rowlee, photo.

Peat bog and lily marsh, New Haven, Oswego co.

ners are marked by Albion and Holley on the north and Byron and East Oakfield on the south, and continues westward to a point about 4 miles north of Akron. The towns of West Albania, Genesee co. and Edwards, Orleans co. are situated on the northern edge of this westward extension.

Another exists along Black creek northeast of Byron, and also southwest of Shelby in Orleans county.

Many peat swamps exist along the line of the New York Central Railroad, between Amboy and Jordan. These are sometimes underlain by marl, or the latter may be interbedded with the peat.

A sample of the latter from the swamp of the Empire Portland Cement Co. was analyzed by the writer with the following results.

Moisture	55.5
Volatile hydrocarbons	24.02
Fixed carbons	.1
Ash	20.2
	99.82

The ash of this material was quite calcareous.

At Warners streaks of peat are found in the swamp with the marl and clay which is used in the manufacture of Portland cement. The peat forms streaks which run from 3 to 6 feet in depth. Often there is a bed 2 to 4 feet thick between the marl and the clay.

One of the largest drained swamps in the State is that known as Cicero swamp in Cicero township, and located in part along Mud creek. The swamp contains two parts, the main one lying east of North Syracuse and the lesser half located northwestward of the latter place. The larger half is about 4 miles long and 2 to 3 miles from north to south, while the smaller half is about 4 miles long and ½ to 1 mile broad, extending along the valley of Mud creek.

The surface is now underlain by a black muck soil, which is extensively cultivated, while the depth of the peat is as much as 30 feet in places. It is said that attempts were made many

years ago to dig this peat and use it as fuel. In places much moss covers the surface in the eastern swamp, and has been gathered by florists for packing plants.

Again, north and northeast of Canastota is an extensive tract known as Cowaselon swamp, which has been drained by the construction of the Douglass ditch. This affords an excellent section of the material underlying the surface and shows much muck underlain by marl of variable thickness. The area is in places covered by a thick tree growth so that the muck contains many fragments of decaying wood. The soil is extensively cultivated for onions.

Many marshy tracts are found along the shores of Oneida lake. Among these may be mentioned the following localities: west of South Bay, on the land of D. Pack; on the north side of Oneida lake around Toad harbor; at the eastern end of the lake, north and south of Sylvan Beach.

The foregoing localities have been mentioned chiefly for the purpose of pointing out the more important areas in which marshes and bogs exist, and something of the character of the material found in them, but not because they are all supposed to contain peat.

There is a peat bed on the farm of Heman Glass, on the Ridge road, ½ mile west of Lake avenue, near Rochester, covering about 30 acres. The peat and muck are 2 to 4 feet deep. Three miles west of this is another small peat swamp, while a larger one is in the town of Gates about 4 miles west of the city.

Mr D. L. Mott, of Utica, states that in the town of Sangerfield there is a tract known as the "Nine mile swamp." The material is quite deep, but is probably not all peat.

According to Mr W. S. Valiant of Rutgers College, many small bogs occur in the town of Rome.

One of the best deposits is that known as the Rome swamp, which shows the following section:

Swamp muck, 3 to 5 feet
Peat, 3 to 6 feet
Moss peat, 8 to 12 inches
Shell marl 2 to 4 inches

Lake mud, 1 to 2 feet

Coarse and fine gravel, 1 to 3 feet

Hard pan, 18 to 20 feet

These bog deposits range from 1 or 2 to 40 feet in thickness.

Some of the muck has been used as a compost and has greatly improved the character of sandy soils in that vicinity.

Attempts were made at Rome some years ago to manufacture peat fuel from the bog deposits, but the factory burned up and was never rebuilt.

One mile south of Rochester Junction is a deposit of peat on the land of W. A. Keyes.

There are several deposits of peat, or muck, on the farm of William Newton, near Henrietta, Monroe co. In some the depth is over 12 feet. They are used in most cases for raising celery and onions. Mr Newton states that 50 years ago the material was rotten wood, leaves and other vegetable matter, which was not decomposed enough to have the appearance of soil.

Extensive marshes exist near Mendon pond 3 to 4 miles from here. Some of these are getting quite solid in places, and in other places there appears to be a thick turf covering the water of the pond. On the farm of H. C. Dikeman of this town there are also several swamps. In one the section beginning at the top shows:

Soil 4 feet

Mosses and ferns 1½ feet

Leaves, twigs, rotten wood 3 feet

Peat 4 feet

Shell layer

Mr E. P. Clapp of North Rush, states that in the town of Rush there is one bed of several acres, but it lies in an old drainage channel.

Bibliography

Bach, A. Peat Fuel. Inst. Civ. Eng. Proc. 1900–1. v. 147.

Baskerville, C. Am. Chem. Soc. Jour. 21:706.

Bjorling, P. R. Colliery Guardian. 80:1127, 1183, 1294; 81:21.

Bornträger, H. Zur Analyse des Torfes.-Zeit, fur anal. chem. 1900. 39:694.

Brande. On Peat and its Products. Roy. Soc. Proc. Jan. 31, 1851; *also* Am. Jour. Sci. ser. 2. 11:440.

Dana, S. L. Muck Manual. Lowell. 1842.

Ells, R. W. Peat Industry of Canada. Ont. Bur. Mines. 2d rep't. 1892. p. 195.

Gowenlock, N. Peat and its Uses. The Cultivator and Country Gentleman. 1875. p. 275.

Hitchcock, C. H. Reports on Geology of Massachusetts. 1835, 1841, and 1856.

——— Geology of New Hampshire. v.3.

Hunt, T. S. On Peat and its Uses. Canadian Nat. new series. 1884. 1:426-41.

Johnson, S. W. Peat and its Uses. N. Y. 1866.

Koller, Theo. Die Torfindustrie. Hartleben, Wien. *Abstract in the* Zeitschrift fur praktische Geologie. 1899. 24:24.

Leavitt, T. H. Facts about Peat. Bost. 1867.

Lesquereux, L. Origin of Coal. Pa. Geol. Sur. An. Rep't. 1885. p. 109; Hayden's survey. 1872 (Sphagnum as a Peat-maker).

Lyell, C. Principles of Geology. 2:502.

Müller, G. Die Verbreitung der Deutschen Torfmoore nach statistischen Gesichtspunkten dargestellt. *Abstract in the* Zeitschrift für practische Geologie. 1899. 24:193, 277, 314.

Page, W. H. Making Coal of Bog Peat. Iron Age, Aug. 18, 1898. 62:3.

Roth, J. Alg. Chem. and Phys. Geol. 2:639.

Schöndeling. On Manufacture of Peat Fuel. Gluckauf, 36:793-97; *abstract in the* Jour. Iron and Steel Inst. 1900. 2:487.

Senft, F. Humus, Marsen, Torf, und Limonit-Bildungen. Leipzig 1862.

Seyfert, A. G. Peat in Canada. Eng. and Min. Jour. Sep. 23, 1899. p. 371.

Shaler, N. S. Fresh-water Morasses of the United States. United States Geol. Sur. 10th An. Rep't.

——— On Peat and Swamp Soils. United States Geol. Sur. 12th An. Rep't. p. 311.

Sherzer, W. H. Mich. Geol. Sur. 7:10, 24, 156, 157, pt 1, Geol. of Monroe County.

White. Geol. Ia. 1870. 2:275-88.

Winchell, N. H. Glacial Lakes of Minnesota. Geol. Soc. of America. Bul. 12:109.

Zirkel. Petrographie. 1894. 3:626.

Peat, its Use and Value for Fuel. Ont. Bur. of Mines. 1st rep't. 1891. p. 175.

Moss litter and the Special Advantage of Sphagnum. Ont. Bur. of Mines. 1896. p. 185-92.

Ont. Bur. Mines. 1900. p. 21.

Mineral Industry. 2:489; 7, 191.

Wis. State Agric. Soc. Trans. 1874-75. p. 75-92; Geol. Wis. 2:240-46.

Utilization of Belgian Peat. *Note in* Eng. and Min Jour. Oct. 4, 1899.

Geol. Ohio. 1:221, 509, 571; 2:222; 3:454, 499.

Making Peat Briquettes by Electric Power. Eng. and Min. Jour. 1902. 74:41.

MOLDING SAND: ITS USES, PROPERTIES AND OCCURRENCE

BY EDWIN C. ECKEL

In the preparation of the following paper, free use has been made of such published sources of information as were available, the more important of the books and papers consulted being listed at the close of this paper. In addition to these published discussions of the subject, Dr F. J. H. Merrill has placed at the disposal of the writer the material accumulated by Mr J. N. Nevius while assistant in the State Museum. Mr Nevius's notes relate almost entirely to the local details of the deposits in Albany county and have been of great service to the present writer.

The uses of molding sands

Molding sands or closely similar materials are employed in making castings when metallic molds are not used. The spaces to be filled by the castings are formed usually by pressing a pattern into the molding material, removing the pattern as soon as the proper imprint has been made in the sand. The pattern is usually made of wood and must be an exact counterpart of the casting which is to be made. In case the casting is to have recesses, or holes, such spaces must be provided for by putting suitable cores in the molds. The cores are commonly made of clayey sand or loam. Short cores can be made from rock sand, the material resulting from the decay of rock in place; but longer cores require the addition of seashore sand in order to secure sufficient porosity. Occasionally patterns are dispensed with, the workman forming the mold in the sand either by hand or by the use of mechanical contrivances. Commonly the molding material is held in two boxes, clamped together when in use, about half the mold being in each box. In this case, as the top box must be removed temporarily in order to take out the wooden pattern, a layer of "parting sand" is dusted over the top of the molding material held in the lower box. This so called

parting "sand" is usually dry brick dust, dry powdered cinders or some similar dry and fine material.

In some of the commoner classes of work, where a smooth surfaced casting is not required, the above operations are all that are necessary to prepare the mold. In finer work, however, after the mold has been made, its surface is dusted with oak charcoal dust or with finely powdered coal. When the molten metal is poured in, these materials will ignite, causing a thin layer of gas to form between the metal and the sand. This results in giving a smooth surface to the casting, as it prevents the metal from entering the minute interstices between the sand grains. Of the two materials above noted as being used for this purpose, charcoal is commonly employed for light castings, being dusted over the mold as described. In heavier work, coal is used, and is often not only dusted over the mold but also mixed with the sand before the mold is prepared.

In English foundry practice, and in practice on the continent of Europe, artificial molding sands are often employed, and such natural sands as are available often require mechanical treatment before being fit for use. The New York deposits, however, yield a high grade of natural molding sand, and such different degrees of fineness can be obtained from these sand beds that little or no artificially prepared sand is used in this country.

Requisite properties of molding sand

The principal properties which should be possessed by a sand to be of service as a molding sand, are refractoriness, porosity, tenacity and fineness. As will be seen later, several of these properties are, to a certain extent, incompatible. For example, a highly refractory sand can not well be a sand possessing a very good bond. In such cases the particular use to which the sand is to be put will determine which of the properties is the more important.

Refractoriness. The refractoriness of a sand depends largely on the amount of silica it contains, being greatest in the sands highest in silica. The presence of any considerable amount of lime or alkalis, on the other hand, decreases the refractoriness

of the sand. Clay, though refractory enough as a constituent of a molding sand, bakes at a high temperature, and therefore tends to cause both shrinkage and loss of porosity.

No analyses of American molding sands are available for insertion in this paper. The analyses following will suffice to give the reader a good idea of the composition of standard foreign molding sands. Of the 12 analyses given, numbers 1, 2, 3, 5 and 12 are to be found in Percy's *Metallurgy*, 1:152-54; while the remaining seven analyses are quoted in Crook & Rohrig's *Practical Treatise on Metallurgy*, 2:627. The analyses have, in the following table, been arranged in the order of their content of silica.

Analyses of molding sands

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O
1	92.913	5.85	1.249	tr.	--------	--------	--------
2	92.083	5.415	2.498	tr.	--------	--------	--------
3	91.907	5.683	2.177	.415	--------	--------	--------
4	91.61	2.11	2.53	tr.	--------	--------	--------
5	90.625	6.667	2.708	tr.	--------	--------	--------
6	90.25	4.1	5.51	.23	--------	--------	--------
7	88	2.78	3.77	.73	--------	--------	--------
8	87.6	7.7	3.6	.96	--------	--------	--------
9	86.68	9.23	3.42	.96	--------	--------	--------
10	83 –77	8.2–7.7	4–2.8	------	.73–.38	5.78 to 3.17	
11	79.02	13.72	2.4	------	.71	4.58	
12	67.6	17.64	*a* 1.6	.86	1.41	3.69	.14

a FeO 2.3

1 From Manchester, England. Analyzed by Kumpmann

2 From the foundry of Freund at Charlottenburg

3 Employed for bronzes at Paris, France

4 Employed at Rothehutte. Analyzed by Streng

5 From the establishment of Lagua near Stromberg

6 From Lunenburg. Analyzed by Sauerwein

7 From Konigshutte. Analyzed by Bierworth

8 From Birmingham, England. Analyzed by Sauerwein

9 From Sheffield, England. Analyzed by Sauerwein

10 From Naples, Italy. Analyzed by Jwanow

11 Employed at Ilsenberg. This sand is an artificial mixture, and is said to "consist of three different kinds of material, namely—common argillaceous sand, sand found in alluvial de-

posits, and sand from solid sandstone. As the first two contain clay, they are carefully heated to dehydrate the clay. The sandstone is crushed under a hammer, and mixed with an equal weight of each of the other two kinds of sand. The mixture is ground by iron balls in a revolving drum, and afterward passed through a flannel-lined cylinder, which moves up and down; it is thus obtained in the state of the finest flour, which in molding may be made to receive the most delicate impressions." Analyzed by J. Spiller

12 Employed in Japan. Analyzed by W. J. Ward

Porosity. The pore spaces between the grains of sand must be large enough, and numerous enough, to permit the free passage of air, and of such gases as may be formed during the operation of casting. At the same time, the pores should not be so large as to permit any of the molten metal to enter the sand.

The porosity of a sand will depend largely on the size of its constituent grains, and on the relative proportions of the various sizes. Porosity will also be dependent on the amount and character of the material which gives the sand its bond. A molding sand whose bond, in the natural state, is dependent partly on the presence of organic matter will become more porous on firing; while a sand held together by clayey material will tend to become less porous at high temperature, owing to the baking of the clay.

Fineness. The fineness necessary in the sand depends largely on the character of the work for which it is to be used. Molding sands are roughly graded at the point of production, but most foundries require much more careful grading than this. Certain plants issue regular specifications to cover this point, and buy only such sands as have been graded for fineness to meet such specification.

Tenacity. The tenacity, or "bond," of a sand is an important quality, as on it depends the capacity of the sand, both to take the shape of the pattern properly, and to retain this shape despite the weight of the metal poured into it. The bond of a sand is usually due to the presence either of organic matter, or of clay. Organic matter, while an excellent bond for an

unburned sand, burns out at a comparatively low temperature, and is therefore of no service to a molding sand. Clay gives an excellent bond, but, if present in quantity, it tends to reduce the porosity of the sand, as has been noted above.

Occurrence of molding sands

In New York State the largest and best known deposits of molding sand are those which occur in Albany county and in the adjoining parts of the Hudson river valley. There, deposits contain sands of various degrees of fineness, and furnish a large part of the molding sand used in the eastern United States.

The molding sand occurs in thin beds, overlain by soil and underlain by clay. In some places the covering of soil has been removed by the action of streams, leaving the molding sand exposed at the surface of the ground. When thus exposed to the atmosphere, the molding sand can be readily distinguished from common sand. In a strong wind the ordinary sand is blown about readily, while the molding sand, owing to its contained clay, remains unmoved. The sides of a road-cut in common sand will fall in till the angle of repose of the sand has been reached, while a cut in molding sand will remain with walls vertical, or nearly so, for some time.

Occasionally the molding sand is dug and marketed by the owners of the land on which it occurs. Usually, however, it is taken out by dealers, who either pay a certain royalty for each ton of sand excavated, or pay a fixed sum for all the sand that can be obtained in a given area.

The handling of the material is simple, as the stripping is usually thin, while the molding sand is readily excavated.

Dr G. P. Merrill has examined samples of Albany county molding sand under the microscope; and states[1] that "the Selkirk molding sand is of a yellow brown color, showing under the microscope angular and irregular rounded particles rarely more than .25mm in diameter, interspersed with finely pulverulent matter which can only be designated as clay. The yellow brown color of the sand is due to the thin film of iron oxid which

[1] U. S. Nat. Mus. Rep't for 1899, p.476-77.

coats the larger granules. When this film is removed by treatment with dilute hydrochloric acid, the constituent materials are readily recognized as consisting mainly of quartz and feldspar fragments (both orthoclase and a plagioclase variety), occasional granules of magnetic iron oxid, and irregularly outlined scales of kaolin, together with dustlike material too finely comminuted for accurate determination. Many of the larger granules are white and opaque, being presumably feldspar in transition stages toward kaolin. An occasional flake of hornblende is present."

In Ohio the Albany molding sand is being gradually displaced in the trade by local sands. The principal points in Ohio at which molding sands are obtained are Zanesville, Sandusky, Hamilton, New Lexington, Vincent and Rushville.

Somewhat farther west, the molding sands chiefly used are obtained in the neighborhood of Indianapolis, Centerton, Delhi, St Joseph and St Louis. Large quantities are mined near the Fox river in Illinois, at McHenry, Cary, Batavia, and Wedron. These are all fine grained sands and are used for the smaller iron or brass castings.

A coarse sand used for large castings is obtained in the vicinity of Brazil Ind. Other good sands suitable for heavy work, are obtained near Valparaiso and McCove Ind. and Racine, Milwaukee, Kenosha and Beloit Wis.

Bibliography of molding sand

Bagshaw, Walter. On the Mechanical Treatment of Moulding Sand. Inst. Mech. Eng. Proc. 1891. 43:94-107, pl. 25-29.

Crooks, W. & Rohrig, E. Practical Treatise on Metallurgy. v. 2, Copper, Iron. 1869. p. 876.

Molding and casting are treated on p. 625-40, 660 *et seq.*

Lineham, W. J. Textbook of Mechanical Engineering. 804p. 1895.

Molding and molding sands are discussed on p. 3 *et seq.*

Merrill, G. P. Guide to the Study of the Collections in the Section of Applied Geology, the Non-metallic Minerals. U. S. Nat. Mus. Rep't for 1899. 1901. p. 155-483.

Molding sands are discussed on p. 474-77.

Nason, F. L. Economic Geology of Albany County. N. Y. State Geologist. 13th An. Rep't. 1894. p. 263, 287.

Description of the molding sand deposits and industry is to be found on p. 268-71.

Percy, J. Metallurgy. v. 1. Introduction, Refractory Materials and Fuel. 1875. p. 596.

Molding and casting sands are discussed on p. 152-54.

PALEONTOLOGY

The field work of the division during the season of 1901 involved the study of several special problems, viz: the relations of the fauna of the Ithaca group in central New York; the waterlime strata of Herkimer county and contents; the stratigraphic and paleontologic relations of the Potsdam sandstones of the Lake Champlain basin to the overlying limestones; the limestone reefs in the Clinton beds; the Guelph horizon and its fauna in the section at Rochester and westward; the limestones of the Marcellus stage and the origin of their faunas; the character of the so called Hudson river beds of the northern Hudson valley. In addition to these special problems, the following stratigraphic work was begun and essentially completed, viz: the areal stratigraphy of the Tully quadrangle; the mapping of the Canandaigua and Naples quadrangles. This work has been carried out in great detail for the purpose of demonstrating in how far the topographic quadrangles will serve the utmost requirements of our present knowledge. This mapping it is proposed to accompany with a paleontologic map on the same base. In cooperation with the United States Geological Survey, the completion of the areal geology of the Olean and Salamanca quadrangles.

The following work was also done in the tracing of formational contact lines, viz: contacts of formations in the region about the Tonawanda and Oak Orchard creek swamps.

The last Legislature made a small provision for the excavation of mastodon bones near the village of Monroe, Orange co. These excavations were duly made, and, though the appropriation proved insufficient for the completion of the work, about one half of the bones of the skeleton were obtained.

Outside of the permanent staff of the department, the following gentlemen have been engaged in the season's work, four of these having volunteered their services: Charles Butts and Myron L. Fuller of the United States Geological Survey, Gilbert

van Ingen, C. A. Hartnagel, Professor A. W. Grabau, H. W. Shimer, R. F. Morgan, Charles Erving, T. W. Pierson.

In the office have been completed the catalogue of type specimens of the Paleozoic fossils of the museum, about 5000 in number; also a study of the Guelph fauna of the State, and reports on various other problems as indicated in the publications of the year, namely: bulletin 39, Paleontologic Papers, no. 1; bulletin 42, Hudson River Beds near Albany and their Taxonomic Equivalents; bulletin 45, Guide to the Geology and Paleontology of Niagara Falls and Vicinity; memoir 3, Oriskany Fauna of Becraft Mountain, Columbia County; annual report for 1900.

Progress has also been made on the study of various other problems of interest. Full details of the work of this division are given in the separate report[1] of the state paleontologist.

MINERALOGY

Mr H. P. Whitlock, assistant in mineralogy, began work Jan. 1, 1901.

In this division work has progressed along several different lines.

1 A card index of the mineral localities of New York State has been compiled, and at present consists of 1421 cards arranged as follows:

a A locality card is placed at the head of each species, on which are listed the localities at which the species occurs. This serves as a means of quick reference and is supplemented by,

b A descriptive card for each occurrence, giving details of exact locality; peculiarities of crystal form, structure and color; geologic and mineralogic association.

This index has been compiled with considerable care from a number of sources and has been enlarged by study of the collections of the Egleston Mineralogical Museum of Columbia University and that of the American Museum of Natural History. Special care has been taken to locate references to old deposits with respect to modern maps, and to this end some research

[1] N. Y. State Mus. Bul. 52.

has been conducted in histories of the various counties and old maps.

The work of compilation has involved reference to the following authorities:

Beck, Lewis C. Natural History of New York; Mineralogy. 1842

Cleveland, P. Elementary Treatise on Mineralogy and Geology. 1822

Dana, E. S. Textbook of Mineralogy. 1898

Dana, J. D. System of Mineralogy. Ed. 6. 1892

——— Manual of Mineralogy and Lithology. 1884.

Fletcher, L. British Museum List of Meteorites. 1888

Ries, H. The Monoclinic Pyroxenes of N. Y. State. N. Y. Acad. of Sci. Ann. June 1896

Smock, J. C. N. Y. State Museum bulletin 7

The work of compilation has been further supplemented by visits to several of the mineral localities, reconnaissance work and field notes. The index has already proved of some value in the collecting work of the department, and will constitute a basis for a type collection of New York minerals, which it is planned to form from duplicate material as soon as there is adequate space.

2 The curatorial work of the department may be classed as follows:

a The principal collection installed in the wall cases has been completely rearranged, added to and disposed to give more prominence to the more valuable material and also to show in the outer lines of specimens a representative series involving all the species and varieties represented in the collection and arranged in accordance with the system of J. D. Dana. Care has been taken to display the best of the material available as well as the most characteristic occurrences and associations. A set of 128 explanatory cards, giving a brief description of the more important species, has been distributed throughout the collection, and a set of Krantz crystal models in wood, carefully selected to show the more common crystal forms, has been like-

wise placed at the head of the principal groups and species. These last two additions considerably increase the educational value of the collection and materially aid the visitor in appreciating many features which render it both interesting and instructive.

b An economic collection to illustrate the minerals of commercial importance has been prepared from duplicate material. This is arranged in accordance with the classification given in William's *Applied Geology* and is supplied with explanatory cards at the head of each division. The economic collection occupies the table cases in the northern section of the mineral museum and is divided into a metalliferous section, including arsenic, antimony, bismuth, gold, silver, platinum, mercury, copper, lead, zinc, cadmium, tin, nickel, uranium, chromium, iron, manganese and aluminum; and a nonmetalliferous section, embracing substances used for chemical purposes, ceramic materials, refractory materials, abrasives, graphic materials, pigments and fertilizers.

c As an accessory to the main collection, a small collection illustrating the crystal habit of quartz has been arranged in a portion of the table case in the southern section. This has been selected to show the variation in the form of quartz crystals from different localities and comprises 105 specimens.

d A collection of 142 polished specimens showing the principal minerals used for ornamental purposes has been prepared and occupies a portion of one of the table cases in the southern section.

Throughout the collections the specimens have been carefully examined, in some cases relabeled and in many instances redetermined.

3 The work of visiting localities and collecting has progressed during the month of May, and a reconnaissance of some of the mineral localities in Jefferson and St Lawrence counties has been made. Mineral specimens have been collected as follows:

Pillar Point, Jefferson co.—Barite showing an interesting association of calcite. Exhibited at the Pan-American Exposition.

Antwerp, Jefferson co.—Hematite in radiating groups of flat crystals. A sphalerite crystal, 12 millimeters in diameter, apparently new to this locality. Stilpnomelane, variety chalcodite, in velvety masses. Siderite in detached rhombohedral crystals, frequently twinned. Ankerite in rhombohedral crystals and curved masses. Millerite in hairlike radiating needles.

Talcville, St Lawrence co.—Hexagonite, amphibole, pseudomorphs and talc.

Gouverneur, St Lawrence co.—Wernerite in a well modified crystal four centimeters in diameter. Tourmalin, brown variety.

Many of the specimens have been added to the main collection, and the remainder are being reserved for exchange purposes.

4 The work of publication in this division has consisted in the preparation of a guide to the mineral collection in the form of a museum bulletin, the text and drawings for which have been completed.

GENERAL ZOOLOGY

Dr F. C. Paulmier, assistant in zoology, assumed his duties on the first of January.

During the early part of the year his time was wholly spent on the museum collections with the following results.

The two highest groups, the mammals and birds, were in very good condition, and needed only the usual cleaning which is given them once a year. The collection of New York forms in these two groups is nearly complete.

The reptiles and batrachians were not in such good condition, as most of the specimens had been on exhibition for many years and had become very much faded. As shown by the labels, much of the material was that used by De Kay in the preparation of his work on the *Zoology of New York* in 1842 and therefore possesses considerable historical value. Since many of the specimens were useless for exhibition purposes, it was thought best to remove them from the cases and endeavor by collecting new material to fill the gaps thus made.

The fishes in the museum consist of two series of specimens, one of which, collected by Spencer F. Baird, was sent from the Smithsonian many years ago, and the other was collected by Dr T. H. Bean on Long Island in 1898. All the specimens were in the exhibition cases, but, as the two series contained many duplicates, it was decided to remove these, and leave only the best specimens of the others on exhibition.

Among the invertebrates, the very fine collection of shells possessed by the museum needed considerable cleaning, owing to the dust caused by the extensive repairs made in the building. No change was made in its arrangement. The fine collection of corals which occupied seven of the eight cases on the north side of the hall was found to contain many duplicates, which were removed, and the rest were cleaned and replaced in the four narrow window cases. This left vacant three large cases in which to place invertebrates. The sea fans and sponges were also placed in the window cases.

The collection of echinoderms, which contains a fairly representative series of southern starfish and sea urchins, was also cleaned and the duplicates removed.

The old alcoholic collection of invertebrates being in poor condition, it was thought best to remove it entirely from exhibition. A number of the forms have been replaced in systematic order, with order and family labels, by specimens collected on Long Island by Dr Tarleton H. Bean and Mr G. G. Scott. The fact that the museum was closed to the public during the entire time covered by this report made it possible to make a number of changes of this kind without interfering with visitors.

The collection of mounted skeletons, which makes a very good nucleus for a comparative anatomic collection, was carefully gone over and cleaned and some broken or misplaced bones mended or replaced.

A considerable portion of the time of the assistant in zoology has been spent in completing the card catalogues of the zoologic collection of the museum, which had been commenced by his predecessor, Dr Farr. These have been entirely completed, and

it will now be possible to observe accurately the future growth of the collections from year to year.

There have been a number of accessions to the museum during the year, and many forms not hitherto in the collections have been added. This is specially true of the invertebrates. A portion of the invertebrate material collected during the summer has not yet been identified or put on exhibition, but this will be done during the winter.

During September a number of land and fresh-water forms were collected in the vicinity of Albany, and several vivariums and aquariums containing snakes, batrachians, fishes and invertebrates were arranged. These have been placed on exhibition, and it is hoped to continue them on exhibition through the winter.

Since the publication of De Kay's *Fauna of New York* in 1842 no list of the reptiles and batrachians of the State has been published. At my request, therefore, a catalogue of these forms has been prepared; the assistant in zoology preparing the sections on the lizards, tortoises and batrachians, and Mr Eckel, assistant in geology, preparing that on the serpents, a group with which he is well acquainted. This will be issued as bulletin no. 51.

Dr Tarleton H. Bean, since his return from the Paris Exposition, has been actively engaged in completing his catalogue of New York fishes, and a large part of the material is now in our hands.

Dr Marcus S. Farr, who resigned from the position as assistant in zoology in the State Museum to accept an appointment in Princeton University, is still working on the catalogue of New York birds, which will probably be finished during the next year. He reports that, since his transfer, he has been able to devote from one to three hours daily to this work. During October and November 1900, nearly all the time he was able to devote to his museum work was spent in the revision of bulletin no. 33, *Check List of New York Birds*, the demand for this paper having been so great as

to necessitate a new edition. All the former records were verified, and five additional state records, discovered since the publication of the list, were added, bringing the total number of birds of which we now have satisfactory state records up to 391. That the present list may be of greater use to bird students, those species known to have bred in the State are so designated.

Later on, he devoted his time very largely to the study of bird skins, preparing descriptions of the different species, giving size (measurements), coloration and its variations in the sexes, adult and immature, in summer and winter plumages. A large series of eggs has also been studied, measurements taken, and the color markings described.

He still has quite a large correspondence with our corps of volunteer observers, and a great many letters have been written, acknowledging reports sent in, asking for information on special points or answering questions in regard to the occurrence or distribution of different species.

A few additional observers have volunteered their assistance, and much valuable information has in this and other ways been secured. Important additions have also been made to our series of photographs for illustrative purposes, and it is believed that the series will ultimately be quite complete.

Much time has also been spent in tabulating the local lists sent in by those who have so kindly aided us in this work. All the available literature on New York birds has been very carefully examined, data on distribution, migration, etc., have been collected, and the matter is now in such shape that with the time he is able to devote to this work outside of his other duties, he expects to be able to conclude the preparation of his final report not later than one year hence.

Zoologic field work

At my suggestion, Dr Paulmier has undertaken an investigation of the habits, life history and development of the edible crab, *Callinectes hastatus*, one of the most important of our marine invertebrates. Early in the spring several preliminary

trips were made to Long Island, to localities where crabs were taken for market, to the United States Fish Commission at Washington and to Crisfield Md. It was finally decided to settle at Bay Shore L. I., where the department of zoology of Columbia University had established a summer station. Through the courtesy of Dr Crampton of Columbia, the facilities of the station were put at the disposal of the museum, and much valuable material, otherwise unobtainable, was secured through his assistance. Practically the entire summer was spent here in collecting museum material, studying the development of *Panopeus*, the mud crab, and gathering a series of specimens illustrating the embryonic stages of that form and of *Callinectes*. A number of trips were made to various places, where catching and shedding crabs for the market was carried on, and many facts of scientific and economic importance were obtained.

Dr Paulmier also spent a portion of his vacation at the biologic laboratory at Woods Hole, and considerable material not elsewhere obtained was there collected.

During July and August 1901 extensive collections of fishes were made in Great South bay, L. I., by Dr Tarleton H. Bean. These collections include 49 species, of which all except three are marine. Though the apparatus for taking fishes was much more extensive and elaborate than that employed in 1898, the number of species secured is unusually small, owing to exceptional natural conditions. It seems probable that the abundant rainfall during the spring and early summer reduced the salinity of the water of Great South bay to a point at which it proved uninviting to most of the fishes which usually migrate from the south in summer, enter the bays of Long Island, and remain there frequently till the late fall.

The same observation was made in bays and sounds as far north as Cape Cod.

The only southern species obtained during July and August were the following: *Hyporhamphus roberti*, one example; *Kirtlandia vagrans*, two individuals; *Trachinotus falcatus*, one young specimen; *Leiostomus xanthurus*, two examples; *Alutera schoepfii*,

two adults; *Echeneis naucrates* and *Palinurichthys perciformis*, pelagic species, were each represented by a single individual, the remora having probably entered with an incoming vessel.

Of the fishes usually to be found in the bay in the months devoted to this investigation the following were not seen: *Raja* sp., *Pomolobus mediocris, Stolephorus brownii, Pygosteus pungitius, Gasterosteus bispinosus, Hippocampus hudsonius, Caranx hippos, Alectis ciliaris, Selene vomer, Trachinotus carolinus, Centropristes striatus* young, *Bairdiella chrysura, Menticirrhus saxatilis, Monacanthus hispidus*, and *Phycis tenuis*.

The following species were present in great abundance: sand shark, bluefish, weakfish, menhaden, Mitchill's anchovy and silver gar.

There was an unusual scarcity of: *Lucania parva, Siphostoma fuscum, Ammodytes americanus, Scomber scombrus, Trachinotus falcatus, Morone americana, Stenotomus chrysops* young, *Cynoscion regalis* young, *Leiostomus xanthurus* young, *Tautogolabrus adspersus* young, *Prionotus* spp. young, and *Alutera schoepfii*.

Edible crabs of large size were very scarce till the latter part of July or early August. Jellyfish were excessively abundant during the entire summer, and were observed frequently to contain small fish of several species, as, for example, *Fundulus heteroclitus, Cyprinodon variegatus*, and *Apeltes quadracus*.

Several diamond-back terrapin were seen in Colonel's Island creek, July 16, and one of them was secured for the Museum.

One species of fish, observed in Clam Pond cove, could not be caught. It was the banded rudder fish, *Seriola zonata*. Several young mackerel, *Scomber scombrus*, were observed in the same cove but were not taken.

The apparatus employed, included seines, gill nets, oyster tongs, clam tongs, eelpots, spears and lines. Much attention was given to night fishing with lanterns and gill nets. In accordance with his instructions, his efforts were directed chiefly to the study of the breeding and feeding habits of the marine fishes. The work began too late to cover the breeding season of the majority of the fishes, but many observations were made on the

movements and the food of the important sea fishes, and these will be incorporated in the final report on the collections.

The common toadfish *Opsanus tau* was still in breeding activity during the summer. Eggs were found attached to submerged stakes, and under sunken pieces of staves, or other wood, and once under a fragment of an old dress. In most instances the eggs were nearly hatched or in process of hatching; and sometimes the very small fish remained on the space covered by the eggs and embryos. The wonderful tenacity with which the egg is fastened to bark or wood is of extreme interest. Long after the embryos have disappeared, the attached portion of the shell remains and can not be removed without actual cutting from its lodgment.

Early in August two examples of the common eel which are apparently of the male sex were secured at Whale House Hole, on the south side of the bay.

The collection contains two very fine specimens of the rough silverside, *Kirtlandia vagrans*, which Dr Bean announces as identical with the *Kirtlandia laciniata* of his report for 1898. A study of the numerous young mullet in the collections made for the State Museum and in the United States National Museum reveals the fact that the genus Querimana of Jordan and Gilbert is merely the young form of Mugil. The anal fin of all young mullets has two spines till the fish reaches a length of say 35 to 40 millimeters, when the first ray has become converted into a weak, but true, spine.

Prof. James L. Kellogg of Williams College continued for the State Museum, during June and July, his valuable work in the study of the life history of the edible clam. He proceeded to the east end of Long Island to seek, in the vicinity of Great Peconic bay, a favorable locality for experimental culture of the hard clam. This he found in the vicinity of Jamesport, where some small clams were planted. Subsequently he went to Cold Spring Harbor and there planted some additional individuals in the most favorable localities which could be se-

cured. These clams were planted with a view to demonstrate the following points:

1 The relative amount of growth in clams of different sizes under similar conditions. The clams were measured before planting, those of a size being put together in groups. The plan is to determine now the arithmetical mean (length) of each set, for comparison with length of clams when planted, then to determine the volume (by displacement in water) of clams the size of those planted and of those of the size of the mean, that the percentage of increase in volume may be found.

2 The relative amount of growth in slow and rapid currents. Unfortunately where currents were slow, the bottom appeared to be unfavorable.

3 The effect of exposure at low tide. A line of flower pots extending from a point considerably below low water mark to a point on the beach above low water was planted with clams of a size.

4 The effect of position above the bottom. Clams were inclosed in galvanized wire cages wired to stones resting on the bottom. It would be an important thing to show growth on rocks above the bottom as in French oyster claims, but the soft clam does not do well under such conditions.

These are the chief points aimed at. To be complete, the experiments ought to be carried out on a large scale, but, if these beds are not disturbed, the results should be good.

Miss Elizabeth J. Letson, director of the museum of the Buffalo Society of Natural Sciences, has continued her studies of the molluscan fauna of western New York and has made extensive collections. She has also completed during the year a check list of the land, fresh-water and marine mollusks found in the State of New York. This check list comprises 416 species, all the available published lists and references from 1843 to 1874 inclusive having been utilized in its preparation. It will be published, after amplification by the inclusion of such references as have appeared subsequent to 1874, as a bulletin of the State Museum.

REPORT ON THE FISHES OF GREAT SOUTH BAY, LONG ISLAND, COLLECTED IN THE SUMMER OF 1901[1]

BY DR TARLETON H. BEAN

Investigations carried on for the New York State Museum during July and August, 1901, in Great South bay, L. I., resulted in the collection of 49 species of fishes, all of which but three are marine. Notwithstanding the great increase in the amount of netting and other appliances employed in fishing, the aggregate of species secured was disappointing. This was doubtless due to the unusual freshness of the water of the bay, caused by excessive rains in the spring and early summer. The methods pursued in the investigation were the same as those followed in 1898, with this exception, that, in accordance with the instructions of Director Merrill, attention was paid chiefly to the habits of the fishes, and not so much to obtaining duplicates for the museum.

The excessive abundance of jellyfishes of various species was one of the noteworthy features of the season. The common Cyanea was the most characteristic of the species observed, and this was so abundant as to constitute a perpetual nuisance not only to fishermen, but, in many localities, to bathers. The great mass of gluey particles which attached themselves to the nets set in the water, especially at night, rendered the work of fishing unusually difficult and, of course, generally resulted in a small catch.

On July 20 a number of Cyaneas were caught in a dip net at Colonel's Island on the south side of Great South bay, and in their stomachs were seen several species of little fishes: *Fundulus heteroclitus*, *Cyprinodon variegatus*, and *Apeltes quadracus*. In some cases the fish were half digested.

The low salinity of the water was probably responsible for the absence of most of the southern fishes which migrate northward, as a rule, in summer. Of these, only about a half dozen species entered the bay at any time during the two months; and these

[1]Not edited according to the rules of the University.

were: the halfbeak, the rough silverside, the short pompano, the spot, and Mitchill's anchovy. Besides these, two pelagic species, the black rudder fish and the remora, were also secured. A few of the southern species passed along the south shore of Long Island, but did not enter the bay. These were: the silvery anchovy, the mackerel scad, and the big-eyed scad.

The use of lanterns at night for spearing and netting fishes was again taken up, and with good results, though the time so occupied was devoted principally to observing the movements of the fish and their attitudes in the water or at the bottom. The silver gar was almost uniformly seen at the surface, following the light, or keeping abreast of it, and usually near at hand; but occasionally a large fish of the species, startled by the sudden appearance of the light, darted with great swiftness away from the approaching boat. The young bluefish usually swam at a little distance below the surface, but also kept near the bow of the boat while it was in motion.

The common bass killy, *Fundulus majalis*, was frequently observed leaping out of the water exactly as the mullet leaps, and was frequently mistaken for that species. The silversides were famous for their almost continuous leaping out of the water in all directions; sometimes they leaped on the bow of the boat and were caught in that way. Eels were not usually much disturbed by the light, except on moonlight nights, when they were very difficult to approach. At the proper stage of tide, usually on the first of the flood, they were to be obtained in very shallow water near the shore, and sometimes in the grass almost out of the water. The peculiar "smacking" sound could be heard as they fed on the killies, silversides, and other small fish.

The fish attracted by our big lanterns were usually silver gars, silversides, killifish and bluefish. The leaping of the silverside and bass killy is very exciting; the bass killy leaves the water almost exactly like the leaping mullet. The silver gar follows the boat, keeping near the light. The young bluefish swim lower in the water in small groups,

keeping pace with the bow of the boat. We caught some of them with a dip net. They are about $3\frac{1}{2}$ or 4 inches long. Some of the silversides appeared to be phosphorescent when they left the water. The silver gar often leaps out of the water and over the water for a distance of several feet. Eels go into the shallow water near the shore and even in the grass in search of small fish. They can be heard "smacking" in many directions. The toadfish are generally curled up on the bottom.

The first long cruise began July 11, on which date the sturgeon fishermen on the ocean beach were still fishing; but the bad weather just prior to that date had interfered seriously with hauling the nets, and the run of fish was almost ended. On July 12 the gill nets set at night showed no signs of sharks; but the presence of menhaden in the bay indicated that sharks were not far off. As an illustration of the poverty of species about the middle of July, the following is a complete list of the fishes taken in three hauls with a gill net and seine combined, the two together measuring 275 feet: *Opsanus tau*, *Pomatomus saltatrix*, *Menidia notata*, *Fundulus heteroclitus*, *Fundulus majalis*, *Apeltes quadracus*, *Anguilla chrysypa*, *Tylosurus marinus*, *Stolephorus mitchilli*, *Pseudopleuronectes americanus*, *Achirus fasciatus*.

It is safe to say that in previous years the number of fishes taken with such an amount of netting would have been twice as large. The result may have been partly due to an easterly wind and ebb tide, which are generally regarded by fishermen as unfavorable for fishing.

July 31 we were present at the hauling of the pound in Clam Pond cove. The only species taken in the pound were a few weakfish, several striped bass, about 200 menhaden, a few dogfish, a half dozen sand sharks, a few small scup, a few fluke, a flatfish, and two horseshoe crabs.

Aug. 9 a new 30 fathom seine, which I had constructed specially for use in Great South bay, was hauled near the mouth of Swan river, and took the following species: striped mullet, common killy, four spined stickleback, common silverside, eel, hogchoker, toadfish, silver gar, young greenbacks (*Pomolobus pseudoharengus*)

menhaden, and goby (*Gobiosoma bosci*). This in another illustration of the scarcity of the migratory fish, as the mouth of Swan river is a famous place for seining southern forms.

The 30 fathom seine was used near Fire Island inlet Aug. 15, and in two hauls it captured only the following species: striped mullet, silver mullet, sea robin, silversides, toadfish, tautog, young bergall, common killy, bass killy, silver gar, young short pompano, flatfish, windowpane, swellfish, pipefish, anchovy, menhaden, and young greenbacks (*Pomolobus pseudoharengus*).

Aug. 16, a 90 fathom gill net, set near Meadow Point at night and watched till 2 o'clock the next morning took only about 250 menhaden, 11 bluefish, and seven weakfish. The water was full of jellyfish, which were fortunately not phosphorescent. Crabs were very abundant and proved very destructive to netting.

Mustelus canis (Mitchill)

Dog shark; smooth dogfish

Watts' pound, Clam Pond cove July 31

Watts' pound, Clam Pond cove July 31

(head) Watts' pound, Clam Pond cove July 31

Watts' pound, Clam Pond cove July 31

Alopias vulpes (Gmelin)

Thresher shark; Swingle-tail shark

(jaws) Ocean beach, Water island May, 1899. H. E. Swezey

Aug. 13, near Cherry grove, the tail of a thresher shark was seen; but no specimen of this species was taken in the bay during the summer.

Carcharias littoralis (Mitchill)

Sand shark

(jaws) Clam Pond cove July 18

Clam Pond cove July 23

(head) Clam Pond cove July 23

The first sand shark secured was taken in a gill net in Clam Pond cove July 18. The species, which is known to fishermen

as Spanish shark, was very abundant during the summer and proved very destructive to netting. A sand shark examined July 19 was found to be feeding on flatfish and eels.

On the evening of July 23 a clam fisherman killed seven individuals of this species by means of a horseshoe spear, and we also speared several. The cove was "full of sharks," to use the language of fishermen, and it was almost useless to set a gill net at night. The sharks, in their efforts to secure the menhaden, caught in the nets, bit great pieces out of the netting, and usually forced the entire body through the rent thus made.

July 31 the sand sharks were found to be feeding on eels.

Anguilla chrysypa Rafinesque

Eel

Howell's point July 13

Whale House Hole Aug. 10

Quantic bay Aug. 22

Swan river Aug. 29

Eels taken at Meadow point July 19 had been feeding on common shrimp, soft edible crab and the common killy (*Fundulus heteroclitus*).

During the summer months the most effective bait for eelpots was found to be the horseshoe crab; and the best form of eelpot for practical use appeared to be a rectangular wire pot.

Eels caught on July 25 had eaten live killifish and shrimp.

An experiment was made with pieces of shark for eelpot bait; but this proved decidedly objectionable, only two small eels having been taken in pots during the night when such bait was used.

Eels speared near Fire Island Aug. 1, had in their stomachs shrimps, crabs, and small mussels.

Aug. 3, eels taken at Meadow point had eaten shrimps and soft edible crabs.

On the night of Aug. 9 eels were very abundant near the Bellport Life-saving station, and about 20 pounds of large eels were speared.

One of the eel fishermen who frequently visited Clam Pond cove, where he set about 300 pots, used silversides (*Menidia notata*) for bait. We found however that they were not equal to the horseshoe crab in the summer season.

The smallest eel taken during the two months was an individual $2\frac{3}{4}$ inches long from Swan river, Aug. 29. An individual $2\frac{7}{8}$ inches long was secured from the craw of a sheldrake in Quantic bay, Aug. 22. July 13 an example $4\frac{1}{8}$ inches long was obtained from Howell's Point.

One of the two individuals seined at Whale House Hole Aug. 10 is apparently a male, and it may be that the other is of the same sex. Male eels were collected in considerable numbers during the summer and fall in Great South bay.

Clupea harengus Linnaeus

Sea herring

Ocean beach opp. Clam Pond cove July 25

The only example of sea herring obtained was the one picked up dead on the ocean beach opposite Clam Pond cove July 25. It was about 4 inches long.

Pomolobus pseudoharengus (Wilson)

Branch alewife; Greenback

Sniping bar, Great South bay July 16
Mouth of Swan river Aug. 8
Whale House Hole Aug. 9
Fire Island inlet, creek Aug. 15
Quantic bay Aug. 22
Smith's point Aug. 23.

The smallest branch alewives taken were seined at the mouth of Swan river Aug. 8. These ranged from $2\frac{1}{8}$ to $3\frac{7}{8}$ inches in length. On the next day, at Whale House Hole, individuals measuring from $3\frac{1}{4}$ to $7\frac{1}{4}$ inches were secured; and Aug. 15 in Fire Island inlet the length of an individual was 4 inches. In Quantic bay Aug. 22 one specimen $2\frac{3}{8}$ inches long was obtained; and Aug. 23 at Smith's point 10 specimens secured varied

from $2\frac{3}{4}$ to 4 inches in length. A half grown fish of this species was caught at Sniping bar, Great South bay, July 16. The young of this species were frequently taken in the fresh water of Swan river and other tributaries of the bay.

Brevoortia tyrannus (Latrobe)

Menhaden; Bunker

Clam Pond cove July 24
Mouth of Swan river Aug. 8
Whale House Hole Aug. 9
Fire Island inlet, creek Aug. 15
West Hampton Aug. 21
Smith's point Aug. 23

Young and adult menhaden were very abundant during the summer. The smallest young fish obtained in Great South bay measured $2\frac{3}{4}$ inches (July 24), the largest, $5\frac{1}{4}$ inches (Aug. 23). These fish were found in all parts of the bay, and even in the brackish or nearly fresh water of the tributary creeks. They were the prey of sharks, bluefish, and weakfish, and they were also closely followed by fishermen, who caught them for the use of the fertilizer factories near Fire Island inlet. Immense schools of the young were seen in the eastern end of Great South bay and in Quantic bay. They were also observed in smaller numbers in Shinnecock bay.

Aug. 29 many schools of menhaden were seen in Great South bay. Some of them were very large schools; others were mere bunches of 2000 or 3000 fish.

The following are the dimensions of young individuals, with the dates of their collection: July 24, $2\frac{3}{4}$ inches; Aug. 8, $3\frac{3}{4}$ to $4\frac{1}{4}$ inches; Aug. 15, $3\frac{1}{4}$ to $3\frac{3}{4}$ inches; Aug. 21, $3\frac{7}{8}$ to $4\frac{1}{4}$ inches; Aug. 23, $5\frac{1}{4}$ inches.

Stolephorus argyrophanus (C. & V.)

Silvery Anchovy

Ocean beach opp. Clam Pond cove July 25—1 specimen

Another specimen, 3 inches long, was found on the ocean beach opposite Meadow point July 26; but its condition was too bad for preservation.

Stolephorus mitchilli (C. & V.)

Mitchill's Anchovy

Howell's point July 13—1 specimen
Duncan's creek July 19—15 specimens
Ocean beach opp. Clam Pond cove July 25—7 specimens
Fire Island inlet, creek Aug. 15—1 specimen
Quantic bay Aug. 22—8 specimens
Smith's point Aug. 23—5 specimens
Ocean beach opp. Clam Pond cove Aug. 28—6 specimens
Blue Point Aug. 29—8 specimens.

Mitchill's anchovy was found almost everywhere in the waters of Great South bay. The smallest individual secured, measuring $1\frac{5}{8}$ inches, was seined in Quantic bay Aug. 22. The largest one in that haul measured $2\frac{3}{16}$ inches. Aug. 28, 16 anchovies of this species were found on the ocean beach opposite Clam Pond cove, having been driven ashore by large bluefish or weakfish. Aug. 29 Mitchill's anchovy was extremely abundant at Blue Point.

Fundulus majalis (Walbaum)

Bass Killy

Fire Island inlet, creek Aug. 15—5 specimens
Clam Pond cove Aug. 27—2 specimens

Fundulus heteroclitus (Linnaeus)

Killifish; Mummichog

Howell's point July 13—2 specimens
Corn Row point July 16—1 specimen
Swan river Aug. 8—2 specimens
Fire Island inlet, creek Aug. 15—3 specimens
Cherry grove Aug. 17—5 specimens
West Hampton Aug. 21—1 specimen
Quantic bay Aug. 21—2 specimens
Smith's point Aug. 23—2 specimens

The smallest common killifish observed were from $\frac{3}{4}$ to $\frac{7}{8}$ inch in length. These were dipped up Aug. 8 in Swan river.

Fundulus diaphanus (Le Sueur)

Fresh-water Killy

West Hampton Aug. 21—9 specimens

Quantic bay Aug. 22—6 specimens

Lucania parva (Baird & Girard)

Rainwater fish

Quantic bay Aug. 22—2 specimens

Smith's point Aug. 23—1 specimen

Cyprinodon variegatus Lacépède

Sheepshead minnow

Corn Row point July 16—2 specimens

Quantic bay Aug. 22—1 specimen

July 16 a specimen of sheepshead killy, seined at Còrn Row point, was infested with a psorosperm parasite.

Tylosurus marinus (Walbaum)

Billfish; Silver gar

Howell's point July 13—1 specimen

Corn Row point July 16—2 specimens

Clam Pond cove July 19—2 specimens

Clam Pond cove July 24—1 specimen

Blue Point July 27—2 specimens

Fire Island inlet, creek July 31—1 specimen

Whale House Hole Aug. 9—1 specimen

Fire Island inlet, creek Aug. 15—2 specimens

(juv.) Fire Island inlet, creek Aug. 15—3 specimens

Cherry grove Aug. 17—1 specimen

(juv.) West Hampton Aug. 21—1 specimen

Quantic bay Aug. 21—1 specimen

(juv.) Clam Pond cove Aug. 27—1 specimen

Blue Point Aug. 29—1 specimen

The silver gar was one of the most characteristic of the fishes of Great South bay during the summer, and it was present in very large numbers though never in great schools. It was frequently observed capturing silversides, which it invariably took

crosswise in its jaws, and afterward turned the fish around for the purpose of swallowing it.

On the night of Aug. 9, near the Bellport Life-saving station, a number of large silver gars were speared. Some of these individuals were more than 2 feet long, and they were playing havoc among the small fish, specially silversides and killifish.

The smallest silver gar obtained during the period of investigation was 2½ inches long. This was collected at Clam Pond cove July 24. An individual 2¾ inches long was obtained at Howell's point July 13. July 16 individuals measuring from 3¾ to 4 inches were obtained at Corn Row point; and July 31 an individual 4½ inches long occurred at Fire Island inlet.

Hyporhamphus roberti (Cuv. & Val.)

Halfbeak

Whale House Hole Aug. 9

This is the only individual of the halfbeak obtained. It measured 9¼ inches in length; the head is 3 inches long; the lower jaw projects 1½ inches beyond the end of the upper jaw. D. 14; A. 17; scales, 52.

Apeltes quadracus (Mitchill)

Four spined Stickleback

Howell's point July 13—1 specimen
Corn Row point July 16—2 specimens
Whale House Hole Aug. 9—3 specimens
Clam Pond cove Aug. 16—1 specimen
Cherry grove Aug 17—2 specimens
West Hampton Aug. 21—1 specimen
Quantic bay Aug. 22—1 specimen
Smith's point Aug. 23—1 specimen

Siphostoma fuscum (Storer)

Common Pipefish

Fire Island inlet, creek July 31—1 specimen
Fire Island inlet, creek Aug. 15—1 specimen

Menidia beryllina (Cope)

Fresh-water Silverside

Howell's point July 13—1 specimen

(juv.) Swan river Aug. 8—1 specimen

Whale House Hole Aug. 9—2 specimens

The smallest fresh-water silverside observed measured 1 inch. This was obtained at Swan river, Aug. 8.

Menidia notata (Mitchill)

Silverside; Friar; Whitebait

Howell's point July 13—5 specimens

Clam Pond cove July 24—1 specimen

Blue Point July 27—2 specimens

Blue Point July 27—5 specimens

Swan river Aug. 8—1 specimen

Whale House Hole Aug. 9—2 specimens

Whale House Hole Aug. 9—4 specimens

Clam Pond cove Aug. 16—6 specimens

Fire Island inlet, creek Aug. 15—29 specimens

Fire Island inlet, creek Aug. 15—1 specimen

Cherry grove Aug. 17—2 specimens

West Hampton Aug. 21—5 specimens

Quantic bay Aug. 21—1 specimen

Smith's point Aug. 23—1 specimen

Clam Pond cove Aug. 27—2 specimens

Blue Point Aug. 29—2 specimens

The smallest individual of the common silverside obtained during the period of investigation was 1 inch long. This was among the specimens collected at Howell's point July 13. The largest one at that locality measured 5 inches. In Swan river Aug. 8, an example 1¼ inches long was secured; and in Clam Pond cove Aug. 16 the sizes varied from 1½ to 5 inches.

An individual obtained in Quantic bay Aug. 21 is 5¼ inches long; the largest specimen secured was from Whale House Hole, Aug. 9: it measured 5⅝ inches.

It was not an unusual thing to find fish from the same haul in which the anal rays varied from I, 21 to I, 24, or even I, 25.

Silversides are often seen skipping out of the water and above its surface, to escape fluke and other enemies.

Kirtlandia vagrans (Goode & Bean)

Rough Silverside

Blue Point July 27—1 specimen

Quantic bay Aug. 21—1 specimen

An example obtained at Quantic bay Aug. 21 is 4¼ inches long. It has the following formula: D. IV, 7; A. I, 21; scales, 46. *Kirtlandia laciniata* (Swain) is not distinct from *K. vagrans*.

Mugil cephalus Linnaeus

Striped Mullet

Blue Point July 27—6 specimens

Fire Island inlet, creek Aug. 15—4 specimens

Clam Pond cove Aug. 27—2 specimens

No very small individuals of the striped mullet were seen. The specimens secured at Blue Point July 27 were from 4⅝ to 5¼ inches long, and those secured in Clam Pond cove Aug. 27 measured from 6 to 6⅜ inches.

The leaping of mullets is well known to every one; but it may be interesting to note that there is no great regularity in the character of the movement out of water. In Swan river, mullets were frequently seen jumping, and it was observed that they sometimes left the water almost perpendicularly, with head up, and dropped back tail first. At other times the fish left the water head first, made an arch, and entered head first. Still others left the water in a horizontal position and fell back on their bellies.

Mugil curema Cuv. & Val.

Silver Mullet; White Mullet

Clam Pond cove Aug. 16—10 specimens

Fire Island inlet, creek Aug. 15—1 specimen

The silver mullet from Clam Pond cove, Aug. 16, measured from 1¾ to 3¼ inches. The example obtained Aug. 15 in Fire Island inlet is 3½ inches long.

The rate of growth of the mullets was seen to be very rapid; but the most interesting observation in connection with the species is the fact that the young mullet, up to the time it attains a length of about 40 mm., has only two developed anal spines. A little later in life the first soft ray becomes converted into a spine by breaking off at a joint, and the sharpening of the end of the portion left, perhaps by attrition on the sharp sand of the localities in which the species habitually lives. The joints are also replaced by hard spiny material, so that by the time the fish has attained to the length of about an inch and a half, it has three spines, the third of which is weak and unsymmetric, but still serviceable. The point of this discovery lies in the identification of the so called genus Querimana Jordan & Gilbert, proposed for small mullets, none of which were known to be much more than 1 inch in length; Querimana is simply the young form of Mugil.

Ammodytes americanus DeKay

Sand Lance; Sand Eel

Fire Island channel Aug. 2—1 specimen

This individual was taken from the mouth of a fluke caught near buoy no. 2.

Scomber scombrus Linnaeus

Common Mackerel

Ocean beach opp. Clam Pond cove July 25—28 specimens

Ocean beach opp. Meadow point July 26—9 specimens

Of the 28 young mackerel picked up on the beach July 25, the smallest measured 2½ inches and the largest 3¾ inches. The specimens obtained July 26 ranged from 2⅝ to 3¾ inches in length.

Decapterus punctatus (Agassiz)

Scad; Round Robin

Ocean beach opp. Clam Pond cove July 25—1 specimen

The single individual found measured 2¾ inches in length.

Trachurops crumenophthalmus (Bloch)

Big-eyed Scad

Ocean beach opp. Clam Pond cove July 25—1 specimen

The individual above referred to was $4\frac{7}{8}$ inches long.

Trachinotus falcatus (Linnaeus)

Round Pompano

Fire Island inlet creek Aug. 15—1 specimen

This example is only $1\frac{1}{4}$ inches in length. It shows, of course, the characteristic dark color of the young on the sides and the larval spines of the preoperculum are well developed.

Pomatomus saltatrix (Linnaeus)

Bluefish

Howell's point, July 13—2 specimens
Corn Row point July 16—2 specimens
Ocean beach opp. Clam Pond cove July 25—1 specimen
Blue point July 27—1 specimen
Meadow point Aug. 3—2 specimens
Whale House Hole Aug. 9—1 specimen
Fire Island inlet, creek Aug. 15—7 specimens
Cherry grove Aug. 17—1 specimen
West Hampton Aug. 21—2 specimens
Quantic bay Aug. 21—3 specimens
Clam Pond cove Aug. 27—1 specimen
Ocean beach opp. Clam Pond cove Aug. 28—2 specimens.

Bluefish caught in gill net at Meadow point Aug. 3 had been feeding on eels.

Aug. 9, near Bellport Life-saving station, young bluefish, some of which were 7 inches long, were taken in the seine.

A bluefish taken Aug. 26, near Cherry grove, had in its stomach a common silverside.

Following are the measurements of young bluefish, arranged in the order of the time of their capture: July 13, $3\frac{1}{4}$ to $3\frac{5}{8}$ inches; July 16, $3\frac{1}{4}$ to $3\frac{7}{8}$ inches; July 25, $3\frac{1}{8}$ inches; July 27, $3\frac{1}{2}$ inches; Aug. 9, 6 inches; Aug. 15, $4\frac{1}{4}$ to $5\frac{3}{4}$ inches; Aug. 21, $5\frac{1}{4}$ to $5\frac{5}{8}$ inches; Aug. 27, $7\frac{1}{4}$ inches; Aug. 28, $3\frac{1}{4}$ inches, these obtained on the ocean beach, where they had been driven ashore by large fish; Aug. 29, $6\frac{3}{4}$ inches.

It was not an unusual thing to find large parasites in the gills of the young bluefish.

Catalogue no. 520 is a bluefish parasite taken at The Cinders, Great South bay, Aug. 30; it looks like the so called "salve bug" (A e g a p s o r a) of the Gloucester fishermen.

Palinurichthys perciformis (Mitchill)

Rudder fish

Wreck on Tobey's Flat Aug. 14—1 specimen

This individual, scarcely half grown, was taken on a hook alongside the wreck at Tobey's Flat. The mouth is very small, and it was at first difficult to find a suitable bait; but after many trials, pieces of living oyster proved effective, and the only individual seen was captured.

Eupomotis gibbosus (Linnaeus)

Sunfish; Pumpkin Seed

Quantic bay Aug. 21—1 specimen

Quantic bay Aug. 21—2 specimens

Quantic bay Aug. 22—2 specimens

Morone americana (Gmelin)

White Perch

Whale House Hole Aug. 9—1 specimen

Smith's point Aug. 23—1 specimen

Aug. 23, at least 50 specimens of white perch, some weighing as much as 1 pound each, were seined at Smith pond. This species is reputed to be very shy, and fishermen declare that, when their feeding ground is disturbed, they leave suddenly and go off to a considerable distance. Whether this be true or not, we seldom found the fish except in very small numbers, and usually only small individuals.

Stenotomus chrysops (Linnaeus)

Scup; Porgy

Watts' pound, Clam Pond cove, July 31

Clam Pond cove Aug. 13—2 specimens

The examples obtained Aug. 13 were caught in a gill net.

Cynoscion regalis (Bloch & Schneider)

Weakfish; Squeteague

Meadow point Aug. 3—1 specimen

A moderate number of weakfish were caught in a gill net during the period of these investigations.

Weakfish taken in a gill net at Meadow point Aug. 3 and near Cherry Grove Aug. 26 had been feeding on soft crabs.

A number of weakfish, caught Aug. 29 at Meadow point, had eaten shrimp.

Leiostomus xanthurus Lacépède

Spot; lafayette

Duncan's creek July 19—1 specimen

Quantic bay Aug. 21—1 specimen

The example from Duncan's creek was 3⅝ inches long, and the one from Quantic bay, 7 inches.

Tautogolabrus adspersus (Walbaum)

Bergall; Cunner; Chogset

Ocean beach, Water island June 6, 1899—young

Wreck on Tobey's Flat Aug. 14—5 specimens

Fire Island inlet, creek Aug. 15—2 specimens

Smith's point Aug. 23—5 specimens

The two young bergalls obtained at Fire Island inlet Aug. 15 were each 1⅝ inches long. Their color was yellow. Mr H. C. Swezey collected young bergalls on the ocean beach at Water island June 6, 1899.

Tautoga onitis (Linnaeus)

Blackfish; Tautog

Clam Pond cove July 19—1 specimen

Fire Island inlet, creek Aug. 15—1 specimen

Cherry grove Aug. 17—1 specimen

Smith's point Aug. 23—1 specimen

Alutera schoepfii (Walbaum)

Orange Filefish

Fire Island inlet Aug. 1—adult specimen

Clam Pond cove Aug. 13—adult, from Watts' pound

Spheroides maculatus (Bloch & Schneider)

Swellfish; Puffer

Blue Point July 27—1 specimen

Fire Island inlet, creek July 31—1 specimen

Fire Island inlet, creek Aug. 15—6 specimens

Cherry grove Aug. 17—1 specimen

The smallest swellfish secured during the season was the one obtained July 27 at Blue Point, measuring 2¼ inches in length. The example obtained July 31 was 2⅝ inches long, and those collected Aug. 15 measured 3⅛ to 3½ inches.

Gobiosoma bosci (Lacépède)

Bosc's Goby

Swan river Aug. 8—4 specimens

These were young gobies, measuring from ½ to 1⅛ inches.

Opsanus tau (Linnaeus)

Toadfish; Oyster Fish

Corn Row point July 16—2 specimens

Corn Row point July 16—

Mouth of Swan river Aug. 8—1 specimen

Mouth of Swan river Aug. 8—1 specimen

Whale House Hole Aug. 9—1 specimen

Cherry grove Aug. 17—5 specimens

Smith's point Aug. 23—1 specimen

The collection at Corn Row point includes a lot of eggs nearly hatched and embryos of various sizes, attached to the bark of a submerged stake. Length of the embryos $\frac{3}{16}$ to $\frac{11}{16}$ inch. The eggs adhere firmly to the bark, but most of them drop off after immersion in alcohol. Some older embryos remain with the eggs and newly hatched fish.

The breeding season of the toadfish is much extended during the spring and summer. Eggs were found on the point of hatching late in July. Young fish, obtained July 16, were from ¾ to ⅞ inch long. Aug. 8 a specimen $\frac{13}{16}$ inch was obtained, and Aug. 9 one measuring $1\frac{7}{16}$ inches. Aug. 17 half grown and young individuals were secured.

July 19 many clusters of toadfish eggs were found under sunken pieces of wood. All of these were hatched, and the imprint of eggshells still remains. The shell and other waste portions appear to have been eaten off by small crustacea, but the adhesive power of the secretion with which the eggs are attached is so great that even the crustacea could not entirely remove the shell. In one instance the eggs were found under a sunken piece of an old dress.

Pholis gunnellus (Linnaeus)

Butterfish; Rock Eel

Ocean beach, Water island June 6, 1899

These specimens were collected by Mr H. E. Swezey.

Prionotus carolinus (Linnaeus)

Sea robin; Gurnard

Fire Island inlet, creek Aug. 15—1 large specimen

Prionotus evolans (Linnaeus)

Striped Sea Robin

(juv.) Blue Point Aug. 29—1 specimen

This individual is 2¾ inches long. Young sea robins have been remarkably scarce in all the waters visited during July and August.

Echeneis naucrates (Linnaeus)

Shark Sucker

The Cinders, Fire Island. August

This was the only individual seen. It was presented to the collection by Mr Brion.

Paralichthys dentatus (Linnaeus)

Summer Flounder; Fluke

Fire Island inlet, near buoy no. 2 Aug. 2—1 specimen

Smith's point Aug. 21—1 specimen

Blue Point Aug. 29—1 specimen

Blue Point Aug. 29—1 specimen

On Aug. 1 fluke were seen feeding on small menhaden in Fire Island inlet.

On Aug. 2 two fluke were seen in Wigo inlet again chasing young menhaden. On the same date we caught more than half a barrel of fluke in the inlet, near buoy no. 2, using menhaden for bait. One of the fluke disgorged a sand lance (*Ammodytes americanus*).

Lophosetta maculata (Mitchill)

Windowpane; Sand Flounder

Fire Island inlet, creek July 31—1 specimen

Fire Island inlet, creek Aug. 15—2 specimens

The individual obtained July 31 is 2¼ inches long, and the other specimens were 3¼ and 3½ inches respectively.

Pseudopleuronectes americanus (Walbaum)

Flatfish; Winter Flounder

Blue Point July 27—1 specimen

Blue Point July 27—1 specimen

Fire Island inlet, creek Aug. 15—1 specimen

Clam Pond cove Aug. 16—1 specimen

Cherry grove Aug. 17—1 specimen

West Hampton Aug. 21—3 specimens

Quantic bay Aug. 21—1 specimen

Smith's point Aug. 23—1 specimen

Blue Point Aug. 29—2 specimens

The smallest flatfish obtained were 2¼ inches long. These were secured July 27 and Aug. 16. Aug. 21, examples taken were from 3 inches to 4¼ inches at West Hampton, and 6¼ inches in Quantic bay. In Clam Pond cove Aug. 16 the young flatfish were associated with fluke, silver gar, killifish and tautog.

Achirus fasciatus Lacépède

American sole; hogchoker

Howell's point July 13—1 specimen

Duncan's creek July 19—1 specimen

Smith's point Aug. 23—1 specimen

July 16 several diamond-back terrapin were observed in Colonel's Island creek, and one of these was obtained for the

collection. It is said that the species is occasionally found in considerable numbers in that vicinity.

July 25 a visit was made to the ocean beach opposite Clam Pond cove. The following species of young fishes were found on the beach having been driven ashore by schools of large bluefish or weakfish: young mackerel, bluefish, mackerel scad, big-eyed scad, Mitchill's anchovy, silvery anchovy, and sea herring. The young mackerel were more abundant than any other species.

Aug. 22 efforts were made to haul seine in Quantic bay; but most parts of the bay were full of fresh-water plants, through which the seine could not be safely hauled. Young menhaden, young bluefish, young greenbacks, silversides, fresh-water killy, common killy, short killy, rainwater fish, four-spined sticklebacks, Mitchill's anchovy, and the common pond sunfish were secured.

THE EDIBLE CRAB

A PRELIMINARY STUDY OF ITS LIFE HISTORY AND ECONOMIC RELATIONSHIPS

BY F. C. PAULMIER

In these days, when so many reports on marine economic invertebrates are discussions of the great reduction in numbers and threatened extinction of the more important forms and are filled with plans for remedying this by artificial means, it is a relief to find one form at least, which in spite of being taken in great quantities, still appears to show no diminution in numbers. This is the common edible, or blue, crab, which, from all accounts, is just as numerous now as it was 20 years ago.

In spite, however, of this seeming immunity, which appears to depend on several factors, there is no good reason why the disturbance of natural conditions, caused by the removing of thousands of crabs annually, should not in time have the same effect here that it has had on other forms, and it is quite probable that the same story will be repeated here. It is a well known fact that man never takes any thought as to the preservation of wild forms till the difficulty of obtaining them in sufficient numbers for his purposes drives him to taking measures for preserving them from extinction and for increasing their numbers. In order to do this intelligently, however, some knowledge of the life history, food, habits and relationship of the forms intended to be preserved must be had; and it is a strange fact that the forms of great economic importance have received little or no attention from this point of view till it became necessary to study them in order to devise means for their preservation.

The edible crab also, which, next to the lobster, is the most important crustacean of our coasts, from an economic standpoint, has never received much attention, and practically nothing is accurately known of its life history and habits. On this account and on account of its being the most important crustacean of New York (the catch of lobsters being very small), the writer,

at the request of Dr F. J. H. Merrill, director of the New York State Museum, has undertaken a study of the crab from this and from the economic point of view.

As is usually the case with marine invertebrates, many of the points are obscure and difficult to work out. The present paper therefore contains only a preliminary survey of the subject, summarizing our knowledge of the crab up to the present time.

Callinectes hastatus Ord.[1]

Callinectes hastatus, the common edible, or blue crab, ranges along the Atlantic coast of the United States from Massachusetts south through the Gulf of Mexico to Texas. Outside of these limits it is rarely found. During the warmer months of the year these animals occur in enormous numbers. They are equally at home in either salt or brackish water and may at times ascend up the rivers to where the water is entirely fresh. Thus they are said to have been taken in quantities off the piers at Newburg on the Hudson. Within the limits of New York State they are exceedingly abundant in the many shallow bays along the Long Island coast and around Staten Island. In the latter locality they are said not to be as abundant as formerly, probably on account of the impurity of the water of New York bay.

It is only during the summer that they are thus common, for in the winter but very few are found in the shallow water. Their winter habits are not well understood; but it is known that the majority go out into deeper water, where they probably remain quietly either on, or buried in, the sand and mud among the weeds and grass. Cases of this migration toward deeper water have been noticed on Long Island, where during November the crabs are seen in great numbers, going from the shallower waters of Moriches bay out into Great South bay and thence out into Fire Island inlet. At Bay Shore, for instance, which

[1] In a recent publication by Miss M. J. Rathbun, *The Genus Callinectes*, United States Nat. Mus. Proc. 18:349, the name *sapidus* is given to this species.

is almost opposite Fire Island inlet, no crabs are taken for the market during the summer, though they are reasonably abundant. During November and the early part of December 1901 much larger numbers were observed going toward the inlet and many were taken and shipped to market. This migration of the crabs depends entirely on the degree of cold. In the southern states they may remain in the shallow water throughout the entire winter. Even in the northern states, specially during a mild winter they may remain near shore in the mud and may be taken at times with clam tongs or rakes. A cold snap, however, frequently kills considerable numbers of those in the shallow water. During the winter of 1900, according to the fishermen, a large number of these were thus "winter-killed" and were brought up in clam tongs.

Life history of Callinectes

But very little is accurately known of the life history and development of the common crab. Many isolated observations have been made and published both on this and various other species of the Brachyura, and by putting these together it is possible to get some general idea of its life history. The economic side of the question has been well treated by R. Rathbun,[1] but no similar studies have been made since. The present paper being only a preliminary one, a discussion of the literature will be reserved to a future time.

The eggs of the crab are carried by the female attached to the hairs of the swimmerets on the underside of the abdomen, or "apron" as the fishermen call it. The questions of the time of egg-laying and the length of time the eggs are carried by the female are matters of great importance from the economic point of view, as the destruction of such females with their eggs is always one of the most potent factors in causing the reduction in numbers of an economic or food form.

This fact has been well illustrated in the case of the lobster. In former years, when the lobsters were abundant, it was the

[1] Fisheries and Fishery Industries of the United States. 1880.

habit to take all the females in berry, either selling them as they were, in the market, the eggs to be used for sauce etc., or else scraping the eggs off. In this way thousands of young, some of which would have grown up to replace the adults taken, were destroyed at one stroke. The evil effects of the destruction of such great numbers soon had its effect in the diminution of the supply, and as a result stringent laws have been passed in several states forbidding the taking of spawn lobsters at any season.

The question then arises, Is the crab fishery in danger from the same causes? In considering this, it is necessary to admit that very little is as yet accurately known about the spawning periods of the crabs or the length of time they carry their eggs.

In the article by R. Rathbun[1] it is stated "that at Hampton Va. in 1880 the first spawners were seen by the 1st of March, but they do not usually appear until April. The hight of the spawning season is from May to August, though many spawners are seen as late as November." Also that "Mr R. E. Earll states that about two thirds of the catch during his visit to Charleston in March 1880 were females with bunches of eggs attached. These eggs were still immature, indicating that they would probably not hatch before April or May. Hundreds of thousands of crabs were destroyed with every dozen crabs brought to market."

It is also said that the negroes "scrape off the spawn from the females." These statements are apparently meant to apply to the crabs in shallow water.

However it may be as far south as Charleston, the experiences of the writer in more northern regions were quite different. On a visit to Crisfield Md. in April 1901 the writer questioned the crab fishermen there, and it was shown that very few had ever seen a crab carrying eggs. Statements from fishermen on subjects apart from the mere facts of catching and shipping their product should naturally be received with caution; but it appears probable that, should crabs in berry be at all abundant at that

[1] Loc. cit. p. 642.

region, they would have been noticed. On Long Island the same conditions were found, hardly any of the fishermen ever having seen a crab in berry anywhere along shore.

The investigations of the writer, finally, failed to show any in the shallow waters of the bays and rivers. It thus seems certain that the crabs in berry do not come into the shallow water at any season in the north.

During the latter part of June, however, a few specimens were taken while clinging to a pound net near Fire Island inlet in about 20 feet of water. For the next three weeks none were seen, while small males were quite common. Then the females suddenly appeared in great numbers on the nets, but, as mentioned, none were seen on the shore.

In the case of the crab fishery, then, the case, in the present state of our knowledge, appears to be somewhat of a sectional one. If the conditions in the south are as stated in Rathbun's paper, it is possible that in the course of time the destruction of large quantities of eggs may have its effect on the number of adults. In the north, on the other hand, the habit of remaining in deeper water while in berry, would appear to prevent any diminution of the crabs from such a cause. Crabs are sufficiently abundant in shallow water for all present necessities, and there is no reason now for deep water fishing. Till that becomes necessary, they will be allowed to hatch their eggs in perfect security from fishermen.

The length of time the females carry their eggs is unknown. According to Rathbun (already quoted), spawners were found in Virginia from March to November, the season being at its hight from May to August. At Charleston, two thirds of the crabs carried eggs in March, and Earll believes that these would probably not hatch before April or May. The first ones found by the writer on Long Island in 1901 were, as already mentioned, taken in the latter part of June, but they did not become abundant before the middle of July. These hatched during the latter part of July. It would appear, then, from Rathbun's observations that the eggs are laid early in the spring and are

carried for some time before hatching. The time of laying in the north has, however, not been determined.

In the lobster, according to Herrick, the eggs are laid during the summer, and they are not hatched till the following summer. It is possible that it may be the same in the crab.

As mentioned above, the eggs of the crabs are carried by the female on the under side of the abdomen. They are of exceeding small size compared with the size of the crab, and number somewhere between 2,000,000 and 3,000,000.

The size and number of the eggs of animals depend to a considerable extent on the stage which the young has attained on hatching. That is, if the young is hatched in an immature stage and therefore has to pass through a long larval life, where the destruction of individuals is very great, the eggs will have to be sufficiently numerous to compensate for this destruction. Thus in some of the shrimps, where the young hatch in a form very like the adult, the eggs are large and few. In the lobster, the eggs are relatively smaller and more numerous than in the preceding, and the young hatch in what is known as the schizopod stage, which, while resembling the adult in some respects, still has to undergo a metamorphosis.

The edible crab, on the other hand, hatches at a very early stage and has therefore to undergo a long larval existence before reaching the adult form. During this period the young are perfectly helpless as far as their enemies are concerned and are therefore subject to very great destruction, which, however, is compensated for by their enormous numbers.

The crab at hatching is known as a zoea and differs strikingly from the adult in form. Its body is more rounded and has a large, pointed dorsal spine, an anterior spine between the eyes and two lateral ones. The eyes also are very large. The abdomen, instead of being small and folded under the body, is long, has a forked telson and functions as a swimming organ. No traces of walking legs are apparent, the principal organ of locomotion besides the tail being two pairs of long swimming legs, which are biramous, covered with long hairs, and correspond

to the second and third maxillipeds of the adult. This zoea swims around in the water near the surface and is eaten in immense numbers by fishes and other pelagic feeders. It molts (probably) six times, with but little change of form, except for the appearance of the walking legs, first as small buds, behind the swimming legs. At the next molt, however, the form changes suddenly, becoming much more crablike, though still differing in several points from the adult. By a further series of molts, the megalops, as the stage is called, gradually passes into the definitive crab form.

The exact number of molts which the crab takes to attain the adult form is not certainly known, and the different stages have never been described. From a number of observations by the writer, it seems probable that it takes at least three years for the crab to attain maturity. This agrees with the observations of Mitchill, quoted in the paper by M. J. Rathbun. He also sets the limit of the crab's life at about seven years and states that they do not molt after arriving at maturity. It is certainly true that we do not find such giants among the crabs as we do among the lobsters, but the occurrence of large specimens makes it seem probable that in some cases at least the increase in size continues.

The female in berry can certainly be regarded as being adult, yet she molts again after the eggs are hatched. This leads to the question, whether the crab, as the lobster, can lay more than one batch of eggs. It is generally assumed that she does not, but the question has not been definitely settled.

This molting of the crustacea, shedding it is usually termed, is an operation which in the case of the crab at least adds considerably to the commercial value. The shedding is due to the fact that the outside skin of the crab is hard and incapable of growth, so that, as the animal increases in size, it must be cast off. In the crab this is accomplished by the shell of the carapace, or body, splitting all around the edge. Then the upper part is raised up, disclosing the body of the crab underneath, covered with the new skin, which is as yet very soft. The crab,

by working his muscles, gradually frees his legs and body from the old skin and finally gets entirely out of it. In this stage he is entirely helpless, but the new skin soon hardens, and he is able to walk away. Crabs immediately after shedding are known as "soft shells" and are greatly esteemed for the table, having a market value greatly in excess of that of the hard crab.

This shedding does not take place at any particular time of the summer but depends entirely on the rate of growth. The young crabs molt more frequently than the older ones.

Crab fishing industries of New York

The crab fishing industry is one which, for several reasons, does not appear to flourish on Long Island. In fact, judging from a comparison of Rathbun's paper of 1880 with the observations made by the writer, the fisheries appear to have decreased to a certain extent since then. It is hoped, however, to give at a future time some more exact statistics concerning this.

The crab fishing is divided into two sections, the hard crab and the soft crab industry, each of which on Long Island is restricted to certain localities.

The hard shell crabs are, of course, taken everywhere on the island by the summer residents for amusement, and a few are everywhere taken by fishermen for local use. The fishing for the New York markets is however confined entirely at the present time to the shallow waters of Moriches bay, and practically all the crabs caught are shipped from Center Moriches and Brookhaven. Twenty years ago a number of other places also shipped crabs, but the men say that it does not pay to do it now.

The fishing for crabs at these places commences about the middle of July and lasts well into September or October. After that, the crabs start for deeper water and many are caught and shipped from places in Great South bay. The number of crabs shipped from the two places mentioned averages about 50 barrels a day, running up sometimes to 80, in the hight of the

season. Each barrel contains from 200 to 250 crabs. The exact statistics are not at present available.

The soft crab industry, the "shedding" of crabs for the market, is confined almost entirely to the western end of the island, in the region around Freeport. No examination of the fisheries here was made. At the western end of the island the writer found a number of men who had tried shedding crabs but had given it up, as, they said, it did not pay them for their time. But a single man, at Center Moriches, was found who was making a success of it, and his trade was almost entirely local.

An investigation in the New York markets appeared to show the reason for this rather anomalous state of the Long Island crab fishing. As one man explained it, "the southern crabs have the market, they can start it in April and keep it up all summer till September or October, while on Long Island they can't get in their work before July, and by that time the taste for crabs is partly over." Barring the last statement, the above appears to be substantially the truth. The relatively greater abundance of the crabs in the south (by which is meant the region around Crisfield Md.) and the longer season more than offset the difference in express rates between those places and Long Island. The longer season there enables men to take up crab fishing and shedding as a business, while the shorter time on Long Island does not pay a man to do it.

In the case of the hard crab is the fact that the supply is usually greater than the demand, and the prices are low. It appears, on the other hand, that, even with the extra care and risk of loss among soft shell crabs, the average price of $1 a dozen which is frequently paid on the island to the fishermen, without any middle man, ought to make it pay. It, however, appears to be otherwise.

From this preliminary survey, it would therefore appear that there is no immediate cause for alarm concerning the crab fisheries of New York. This appears to be due to two factors: the nondestruction of the females in berry; and the present

relatively small demand for crabs, which does not lead to fishing for them up to the limit of the supply, or to the destruction of immature forms.

It should not be forgotten, however, that the same feeling of security as to the future has been felt in regard to other forms of economic importance, and that in a number of cases, those forms would now be in a fair way to extinction, were it not for laws regulating their capture and for the artificial raising of the young.

It is therefore proper that we should prepare ourselves while the supply is still sufficient, for the day which will certainly come, when some measures either for restricting the taking of the adult or the protection of the young will be necessary. This must be done in two ways; first, by obtaining all the necessary particulars concerning the life history and habits of the form we wish to preserve, and secondly, by educating the public up to seeing the necessity for such measures.

ENTOMOLOGY

The work of the state entomologist in 1901 has been varied and most important attention has been given to various insect pests which are specially abundant and destructive. One of the most serious of these was the Hessian fly, of which a detailed notice has been prepared.

The three lines of special investigation reported on last year have been continued. The experiments with insecticides against the San José scale have resulted largely in confirmation of the work of last year. The study of forest and shade tree insects has been continued, and many valuable facts ascertained, which will soon be embodied in a memoir. The work of the entomologic field station was continued at Ithaca N. Y., instead of at Saranac Inn as last year, in cooperation with the authorities of Cornell University. Special attention was paid to the smaller dragon flies or damsel flies, Odonata-Zygoptera, and the fish food material collected the preceding year has been studied. These results, together with the study of a family of small flies

(Chironomidae), very important so far as fish food is concerned, will be included in the report on the work at the field station.

There has been no relaxation in the pressure of office work. Correspondence, determination of scale insects for the State Department of Agriculture, and carrying through the press in midsummer two very important bulletins, one on scale insects and the other on insects of the Adirondacks, have made serious inroads into the time which might have been given to investigations during the period when insect activities were at their hight.

The preparation of a large collection for exhibition at the Pan-American exposition took all the time of a special assistant for three months and also made large demands on the office force. This collection will be placed on exhibition in the museum when returned from the exposition.

The extension work has been prosecuted with vigor, and a number of lectures were delivered by the entomologist and his assistant before farmers institutes and various scientific and horticultural organizations. The work of arranging and classifying the State collection has been pushed, and most of the beetles, Coleoptera, have been referred to families. The scale insects Coccidae, and the grasshoppers, Orthoptera, have been determined specifically in most cases. Large additions, which may be estimated at approximately 16,000 pinned, labeled specimens besides a great many in alcohol, have been made to the State collection.

The work of the voluntary observers has been continued, and a large number of interesting and valuable facts have been placed on record. The removal of the office from the old quarters in the capitol to Geological and Agricultural Hall has afforded much needed space and very essential facilities. This change, together with a change in the staff, has necessarily interfered somewhat with the regular lines of work, but the prospects for the coming year are exceedingly bright.

Full details of the work of this division are given in the separate report[1] of the state entomologist.

[1] N. Y. State Mus. Bul. 53.

BOTANY

Specimens of plants representing 320 species have been collected the past season by the state botanist, of which 37 species are new to the state flora and to the herbarium and 16 are considered new species. Descriptions of the new species have been written, and in some cases colored figures have been prepared. A considerable number of mushrooms have been tested in regard to their edible qualities, and of these 11 have been thought worthy of addition to our list of edible species. Colored figures of natural size have been made of these, and it is expected that these figures with full descriptions will be published in the report for 1901.

During the spring months some time was spent in preparing and packing for transportation a collection of specimens for exhibition at the Pan-American Exposition at Buffalo. This exhibit was necessarily limited to the 120 square feet of space allotted to it, but in that space specimens fairly representative of the principal divisions and groups of plants represented in the herbarium were shown. A journey to Buffalo was necessary to put this exhibit in place, and another at the close of the exposition to pack it for return. In the early summer it became necessary to pack up and put in order the herbarium for removal from the capitol to Geological Hall. This removal was strongly urged and finally undertaken before the cases in Geological Hall were ready for the reception of the specimens, in consequence of which considerable extra work was necessary in rehandling the specimens after the completion of the cases.

The collection of wood sections hitherto kept on the third floor of the wing extension of Geological Hall has been rearranged in the cases on the second floor, so far as the completion of these cases will permit.

Full details of the work of this division are given in the separate report[1] of the state botanist.

---

[1] N. Y. State Mus. Bul. 54.

ETHNOLOGY

Rev. William M. Beauchamp has continued his valuable work of authorship and has prepared two important bulletins, entitled respectively *Horn and Bone Implements of the New York Indians* and *Metallic Implements of the New York Indians.*

In September 1901 he made a trip of four days to Perch lake, Jefferson co., inspecting and securing descriptions of over 60 of the remarkable mounds or hut rings still remaining there.

Several trips were made elsewhere, viz, one to the Tonawanda reservation; one to Watertown to examine and describe relics and obtain notes of sites; one to Chaumont for similar purposes; one each to Cayuga and Madison counties. The most important of all was an inspection of several days of sites and relics along the Susquehanna from Binghamton to Waverly. In all these Dr Beauchamp had the valuable aid of local archeologists.

PAN-AMERICAN EXPOSITION

By authority of the board of managers communicated as a result of its official action on Oct. 22, 1900, by which the director of the New York State Museum was made director of the scientific exhibit and an appropriation of $9000 placed at his disposal for the necessary expenses of the work, such an exhibit in its various departments was made and duly installed. Concerning the details of this work, I beg to make the following report.

The first scientific exhibit made by New York State at any general exposition was a small one made at New Orleans in 1886. The first large and comprehensive exhibit was that made at the World's Columbian Exposition in 1893. When the board of managers of the exhibit of the State of New York at the World's Columbian Exposition decided to call on the New York State Museum to prepare an exhibit of the mineral resources of the State and to contribute collections illustrative of its fauna and flora, the work proved to be one of considerable magnitude, specially in the matter of the mineral exhibit, as but little material of economic value had previously been accumulated by the State Museum.

With the liberal allowance made by the World's Columbian board of managers, a large amount of material was brought together, which formed an attractive exhibit, and having been brought back to Albany and deposited in the State Museum, formed the nucleus of the Pan-American exhibit of mineral resources. As, however, mineral industries vary from year to year, it was necessary, in preparing for a mineral exhibit at the Pan-American Exposition, to do a large amount of work in order to fill the various gaps in the mineral collections.

The other divisions of the scientific exhibit were contributed by the state paleontologist, the state botanist and the state entomologist, who, with comparatively small sums of money, were able to gather together a large amount of valuable material and make attractive and instructive exhibits. The details of these exhibits are discussed in the reports of these officers. While the paleontologic, botanic and entomologic exhibits were in charge of the officers of the museum above mentioned, the exhibit of mineral resources was prepared under the immediate supervision of the director of the scientific exhibit.

In the detailed work of gathering the material together, in the labor of installation and in the supervision of the exhibit during the period of the exposition, the director has been most efficiently aided by his assistant, Mr Arthur L. Parsons, to whom cordial acknowledgments are made.

All the material in this exhibit was from localities within the State. The purpose of the exhibit was to illustrate only such materials as are at present of economic importance, or such as show a strong probability of becoming important in the near future. A large part of the material was collected between October 1900 and March 1901.

Though New York does not rank high as a metal-mining state, its nonmetalliferous mineral products are of great value. The clay-working industry alone in 1900 amounted to $7,660,606. The product of the quarries of building stone is second in importance and amounted to $4,039,102, making New York third in the Union in the value of its stone products. The salt industry

for last year amounted to $2,171,418, making New York the first state in the production of salt, while its production of iron ore amounted to $1,103,817 for the same year.

Among the other important industries in the State to be mentioned are gypsum, mineral paint, talc, mineral waters and cement. These, though of secondary importance, bring New York's mineral production to $19,590,084, not including the value of the output of abrasives, graphite, pyrite, fullers' earth and gas.

The specimens exhibited were arranged in six cases, 5x5 feet, four cases 2½x5 feet and one case 2x5 feet. The building stones were arranged on a stand extending the full length of the exhibit, while the clays and clay products were displayed on a pyramid at the center. Each case contained a single group of the materials.

CATALOGUE OF EXHIBITS

Hudson river clays

W. A. Underhill Brick Co., Croton point. Clay and brick

A. McLean, Catskill. Brick clay

P. Goldrick, Haverstraw. Brick

Allison & Wood, Haverstraw. Brick

F. M. Van Dusen, Glasco. Brick clay

Central and western New York clays

T. C. Campbell, Newfield. Paving brick clay

Richard Peck, East Bethany. Clay, drain tile and fireproofing

Glens Falls Terra Cotta & Brick Co., Glens Falls. Terra cotta clay

Paige Bros., Ogdensburg. Brick clay

William Stoutner, Gloversville. Brick clay

Buffalo Star Brick Co., Lancaster. Brick clay

Onondaga Vitrified Brick Co., Warner's. Clay, shale, wire-cut brick, drain tile and fireproofing.

National Web Tile Sewer Co., Syracuse. Web tile sewer

M. J. Mecusker & Son, Jamestown. Brick drain tile and hollow fireproofing

Andrew C. Newton, Crescent. Clay brick and tempering sand

J. Ouimette, Plattsburg. Clay, brick and tempering sand

New York Hydraulic Press Brick Co., Rochester. Clay and brick made at Canandaigua

New York Brick and Paving Co., Syracuse. Brick and clay

Walter E. Hilton, Dunkirk. Clay and brick

Rochester Brick and Tile Manufacturing Co., Rochester. Clay, brick, hollow fireproofing, tile

Brush Bros., Buffalo. Brick

Ogden Brick Co., Binghamton. Clay, brick and tempering sand

Syracuse Pottery Co., Syracuse. Flower pots and seed pans

Lyons Pottery Co., Lyons. Pottery

Standard Sewer Pipe Co., Rochester. Salt glazed sewer pipe

Long Island clays and associated materials

John N. Williamson & Co, New York city. "Kaolin," fire sand, glass sand, brick sand, "kaolin" sand, fire clay, potter's clay, founder's clay, grit and gravel from Northport L. I.

Coles A. Carpenter, Sea Cliff N. Y. Potters' clay, "kaolin" and fire sand

C. L. Sanford, Southold. Clay, brick and tempering sand

M. Meyer, Farmingdale. Clay and brick

Staten Island clays

B. Kreischer & Sons, New York city. Fire sand, "kaolin," fire clay, stoneware clay, fire brick, front brick and terra cotta from Kreischerville S. I.

Slip clays

Albany Slip Clay Co. Albany. *Slip clay* for glazing pottery and for use as a bond in the manufacture of emery wheels

—— Seneca Falls. Slip clay

Shale

Jamestown Shale Paving Brick Co., Jamestown. Shale and brick

Jewettville Pressed & Paving Brick Co., Jewettville. Shale and pressed brick

Preston Brick Co., Hornellsville. Brick and shale

Eastern Paving Brick Co., Catskill. Shale and brick

Celadon Roofing Tile Co., Alfred. Shale for roofing tile

Quartz

P. H. Kinkel, Bedford

Feldspar

P. H. Kinkel, Bedford

Fullers earth

P. D. Penfield, Rome

Granite

J. E. Bailey, Breakneck and Cold Spring

J. H. White and R. I. Allen, Saratoga Springs

R. Forsyth, Grindstone island. Two cubes

A. Gracie King, Garrisons. Two cubes

Mt Eve Granite Co., Mt Eve

New York State Museum. Cubes from Luzerne and Greenfield Centre

Francis Larkin, Ossining

B. B. Mason, Keeseville

E. P. Roberts, Mohegan granite quarry, Cortland

Trap

Frank Bennet, Graniteville, Staten Island

Limestone and marble

Verd-antique Marble Co., Thurman

Walton Marble Co., Port Henry

St Lawrence Marble Co., Gouverneur. Two cubes

D. C. Hewitt, Amsterdam

A. E. Shaper, Canajoharie

Masterton & Hall, Tuckahoe

Old quarry, Hastings

New York State quarries, Ossining

A. L. Pritchard, Pleasantville

J. B. Berridge, Hudson

Glens Falls Co., Glens Falls

R. Jones, Prospect

Evan Thomas, Prospect

James Shanahan, Tribe's Hill. Two cubes

Duford & Son, Chaumont. Also one cube from museum collection

J. J. Barron, Three Mile Bay
S. W. Clark, Willsboro Point
Callanan Bros., South Bethlehem
B. & J. Carpenter, Lockport. Two cubes
J. & C. Carpenter, Lockport. Also a cube from the museum collection
Foery & Kastner, Rochester
J. Hughes, Syracuse
Loren Thomas, Waterloo
P. P. Smith, Union Springs
William Reilly, Cobleskill
D. & H. Fogelsonger, Buffalo
Morris & Strobel, Leroy
Eugene Campbell, Medusa. Cube from New Baltimore
Daniel Lynch, Minerva
South Dover Marble Co., South Dover. Two cubes
Old quarry, Onondaga

Sandstone and bluestone

F. G. Clarke Bluestone Co., Oxford
D. Parmeter, Potsdam. Two cubes
A. Clarkson, Potsdam
Old quarry, Port Henry
B. B. Mason, Keeseville
A. Shear & Co., Duanesburg
L. W. Hotchkiss, Lewiston
Horan Bros., Medina
Mrs John Holloway, Medina
S. F. Kilgour, Sullivan county
James Nevins & Son, Walton
Burhans & Brainard, Saugerties. Two cubes
Ulster Bluestone Co., Malden
Hewitt Boice, Rondout. Two cubes
Portage Bluestone Co., Portageville
Warsaw Bluestone Co., Warsaw
G. I. McClune, Ithaca
A. D. Symonds, Elmira

Alfred Dibble, Belvidere

A. W. Bouton, Roxbury

De Graff & Roberts, Eagle Harbor

Hudson River Bluestone Co., Malden

Thavis & Kingsbury, Hale Eddy

Ralph Cairns, Walton

Gilbert Brady, Rochester

Roofing slate

J. J. McDonough, Slateville. Red roofing slate

Allen & Williams, Middle Granville. Red roofing slate

I. S. Herbert, North Granville. Red roofing slate

Mathews Slate Co., Poultney Vt. Red, green and purple roofing slate

E. J. Johnson & Co., New York. Red roofing slate from quarry at Middle Granville

Penrhyn Slate Co., Middle Granville. Purple roofing slate and glazed slate

Walter C. White, Granville. Red roofing slate

Algonquin Red Slate Co., Hatchhill, Granville. Red and green slate

Portland cement

Empire Portland Cement Co., Warner's. Marl, clay, cement clinker and cement

T. Millen & Co., Wayland. Marl, clay, cement clinker, cement and briquets for testing

Helderberg Cement Co., Howes Cave. Limestone and cement

Glens Falls Portland Cement Co., Glens Falls. Limestone, clay, cement clinker and cement

Wayland Portland Cement Co., Wayland. Marl, clay, cement clinker and cement

Marl

Empire Portland Cement Co., Warner's

T. Millen & Co., Wayland

Natural cement

New York and Rosendale Cement Co., Rondout. Cement rock and cement

Buffalo Cement Co., Buffalo. Cement rock and cement

Union Akron Cement Co., Buffalo. Cement rock and cement

Lawrence Cement Co., Rondout. Cement rock and cement

Cummings Cement Co., Akron. Cement rock and calcined cement rock

Lawrenceville Cement Co., Kingston. Cement rock and cement

Bangs and Gaynor, Fayetteville. Cement rock and cement

Helderberg Cement Co., Howes Cave. Cement rock and cement

Newark and Rosendale Lime and Cement Co., Whiteport. Cement rock and cement

Lime

J. J. E. Harrison, Newburg. Limestone and lime

Chazy Marble Lime Co., Chazy. Limestone and chemical lime

A. R. Davies, North Litchfield. Limestone and lime

C. Williams & Co., Bigelow. Limestone and lime

George E. Holland, North Litchfield. Limestone and lime

Henry S. Smith, Sharon Springs. Limestone and lime

Ossining Lime Co., Ossining. Limestone and lime

House & Brown, Johnsons. Limestone and lime

E. B. Simonds, Shelby. Limestone

E. B. Mather, Sodus Centre. Limestone and lime

L. F. Hall, Ellenville. Limestone and lime

Gypsum

Ezra Grinnell, Port Gibson. Gypsum and land plaster

Cayuga Plaster Co., Union Springs. Gypsum and land plaster

Lycoming Calcining Co., Garbuttsville. Gypsum and plaster of Paris

Consolidated Wheatland Plaster Co., Wheatland. Gypsum and land plaster

English Plaster Works, Oakfield. Gypsum, land plaster, plaster of Paris, wall plaster

National Wall Plaster Co., Syracuse. Gypsum, land plaster, crushed gypsum, plaster of Paris

Bangs & Gaynor, Fayetteville. Gypsum and land plaster

Oakfield Plaster Manufacturing Co., Oakfield. Gypsum, crushed gypsum, land plaster and plaster of Paris

F. M. Severance, Fayetteville. Gypsum

M. R. Anthony, Union Springs. Gypsum and land plaster

Salt

Genesee Salt Co., New York. Evaporated salt from Piffard, Livingston co.

Worcester Salt Co., Silver Springs. Evaporated salt

National Salt Co., New York. Evaporated salt from Warsaw, Wyoming co.

Retsof Mining Co., Retsof, Livingston co. Rock salt from Retsof and Livonia

Onondaga Coarse Salt Association, Syracuse. Solar salt

Iron ores

Hudson River Ore & Iron Co., Burden. Carbonate ore, crude and roasted

Old Sterling Iron Co., Antwerp. Red hematite

Ancram Iron Ore Co., Ancram. Carbonate ore (siderite)

Clinton Iron Ore Co., Clinton. Red hematite

Furnaceville Iron Ore Co., Ontario, Wayne co. Red hematite

A. E. Tower & Co., Poughkeepsie. Brown hematite (limonite) Beekman and Sylvan Lake, Dutchess co.

Witherbee, Sherman & Co., Mineville. Magnetite

New York State Museum, Albany. Magnetite from the following historic mines:

Benson mine, Benson's Mines, St Lawrence co.

Adirondack mine, Newcomb, Essex co.

Fort Ann mine, Fort Ann, Washington co.

French Mountain, Warren co.

Tilly Foster mine, Brewsters, Putnam co.

Mahopac mine, Carmel, Putnam co.

McCollum mine, Southeast, Putnam co.

Forest of Dean, Monroe, Orange co.

O'Neill mine, Monroe, Orange co.

Limonite from Todt hill mine, Richmond co.

Chateaugay Ore & Iron Co., Plattsburg. Magnetite and concentrates

Mineral paint

Francis Thomas, Troy. Slate and slate paint

Algonquin Red Slate Co., Worcester Mass. Slate and paint

Farr & Bailey, Camden N. J. Oil cloth painted with New York State paint

William Connors, Troy. Paint and mortar color

Clinton Metallic Paint Co., Clinton. Iron ore and metallic paint

Wells & Hall, Ogdensburg. Paint, mortar color, paints and iron ore

Delaware Mining, Milling & Manufacturing Co., Roxbury. Slate and slate paint

Garnet

H. Behr & Co. New York

H. H. Barton & Son Co., Philadelphia Pa.

Baeder, Adamson & Co., Philadelphia Pa.

Daniel Lynch, Minerva N. Y.

Millstone

James S. Van Etten, Granite

Emery

Isaac McCoy, Peekskill

Infusorial earth

Thomas Grosvenor, Wilmurt

Dr Oliver L. Jones, Cold Spring Harbor

Talc

Union Talc Co., New York; mills and mines near Gouverneur

Graphite

Joheph Dixon Crucible Co., Jersey City N. J., mines at Ticonderoga N. Y.

Fluorite

New York State Museum, Albany. From Macomb, St Lawrence co.

Barite

From Pillar Point, Jefferson co.

Pyrite

Stella mine, De Kalb Junction, St Lawrence co.

Petroleum

Bolivar, Richburg and Wirt field. Lot 25, Clarksville; 29, Genesee; 18, Genesee; 123, Alma; 5, Scio; 8, Scio; 52, Scio; 8, Scio; 14, Bolivar; 123, Alma; 13, Bolivar; 15, Bolivar; 52, Scio; 64, Bolivar; 16, Bolivar

Bolivar pool. Lot 26, Bolivar

Alma pool. Lot 106, Alma; 110, Alma

Alma P. O. field. Lot 23, Bolivar; 28, Alma; 55, Alma

Clarksville and Niles field. Lot 20, Clarksville

Wirt pool. Lot 60, Wirt

Allegany field. Lot 10, Allegany; Allegany; lot 3, Allegany

Bradford field. State Line; lot 3, Four Mile

Rice brook field. Lot 71, Rice brook; 60, Rice brook

Chipmunk pool. Lot 16, Vandalia; Seneca Reservation

Red House pool. Lot 12, Red House; 11, Red House

Whitesville pool. Lot 80, Whitesville

Andover field. Lot 30, Greenwood; 6, Greenwood

Waugh & Porter field. Lot 13, Bolivar

Fulmer Valley pool. Lot 110, Fulmer Valley; 60, Fulmer Valley

Peat

Wayland Keyes, Rush

Empire Portland Cement Co., Warner's N. Y.

The exhibit installed in the Mines building received the following awards.

Silver medals

Exhibit of mineral products illustrative of the mineral resources of the State

Building stones

Bronze medals

Mineral paint

Crude and manufactured gypsum samples

Clays, shales and their products

Salts

Limestone and cements

Abrasives

Petroleum samples

Slate of different colors

To the other exhibits prepared and installed by the state paleontologist, the state botanist and the state entomologist the following awards were given.

Gold medal

Publications and exhibit of fossil sponges and crustacea.

Silver medals

Botanic collections

Entomologic publications

Forest insects

In ethnology the museum received honorable mention for an exhibit of 20 Indian masks.

MUSEUM BUILDING

The extensive repairs and alterations in Geological hall, begun in September 1900, on account of which it was necessary to close the exhibition rooms to the public, were completed during the past summer, and the museum is again open to visitors.

During the time the building was closed, new hard pine floors were laid over the old floors, which were very much worn, and steel ceilings were put in to cover the old plaster ceilings. The latter had been for years an eyesore and source of constant danger to life and limb, as large pieces of plaster frequently fell, and visitors at times narrowly escaped injury. The small panes of glass in the front windows have been replaced by large sheets of plate glass, which, from the outside, give the building a much better appearance and also allow much more light to penetrate to the exhibition rooms. The plumbing has been much improved, and the old hot air furnaces, which were entirely inadequate to heat the building thoroughly in winter, have been replaced by a steam-heating plant. The entire building, both inside and out, has received several coats of paint and presents a more attractive appearance than ever before.

ACCESSIONS TO COLLECTIONS

Economic geology

Collections

Heinrich Ries. 2 specimens of moss litter from Welland Ont.; 1 of peat from C. H. Post, northeast of Cold Spring N. Y.; 1 of marl from Canastota

Structural geology

Collections

H. C. Magnus. From Rapid Transit tunnel, New York: 7 specimens of mica schist; 4 of garnetiferous schist; 1 of hydromica schist; 1 of epidote schist; 1 of epidote schist with quartz vein

E. C. Eckel. 50 specimens crystalline rocks from Rockland, Orange, Dutchess, and Putnam counties, N. Y., and Fairfield county, Ct.

Mineralogy

Purchases

1 specimen of silver and copper

1 specimen of wernerite, Gouverneur, St Lawrence co.

Donations

George I. Finlay. 1 specimen of allanite, Mineville, Essex co.

B. E. Ingersoll. 1 specimen of epidote, Carmel, Putnam co.

C. C. Brill. 5 specimens of talc, Faceton Vt.

H. S. Peck. 5 specimens of calcite, New Baltimore, Greene co.

Collections

H. P. Whitlock. 3 specimens of barite, Pillar Point, Jefferson co.; 19 of hematite, sphalerite, chalcodite, serpentine, siderite, ankerite and millerite, Antwerp, Jefferson co.; 20 of talc, hexagonite and pseudomorphs, Edwards, St Lawrence co.; 14 of tourmalin, Gouverneur, St Lawrence co.; 19 of calcite, Rysedorph hill, Rensselaer co.

H. C. Magnus. From New York city:

Pyrite vugs from pegmatite, 147th st. and Broadway (R. T. T.)

Tremolite, Kingsbridge ship canal

Tourmalin, 147th st. and Broadway

Garnets in feldspar, 147th st. and Broadway

Garnets in mica schist, 164th st. and Broadway (R. T. T.)
Epidote, Broadway and 55-56th st.
Chalcopyrite and malachite in biotite schist, 137th st. and Broadway
Tourmalin crysts in mica schist, Boulvd. Lafayette, 164th st.
Graphite nodules in calcite, Fordham
Tapering tourmaline crystal, 147th st. and Broadway
Orthoclase, 95th st. and 11th av.
Chondroite and spinel, Fordham
Biotite crystal in feldspar, 147th st. and Broadway
Muscovite crystals, 147th st. and Broadway
Epidote crystals, 137th st. and Broadway
Tourmalin double termination, 147th st. and Broadway
Chalcopyrite on dolomite, Kingsbridge ship canal
Graphite nodules in calcite, Fordham.

Zoology

All material which is listed without the name of the collector has been collected by the assistant in zoology.

MAMMALIA

1 Erethizon dorsatus *L.*, Canada porcupine. Pine Hills, Albany N. Y.

1 Felis domesticus *L.*, common cat, unmounted skeleton, 2 skulls

1 Sciurus *sp.*, squirrel, skull. Madison N. J.

AVES

1 Ardea herodias *L.*, great blue heron. Voorheesville N. Y. Thomas Brewster

1 Branta hutchinsii. *Sw. & Rich.*, Hutchins goose. Purchased of C. F. Posson, Medina N. Y.

1 Pavo cristatus *L.*, peacock, male. Purchased of G. M. Herrick

1 Corvus americanus *Aud.*, crow, skull. Madison N. J.

REPTILIA

9 Eutaenia sirtalis *L.*, garter snake. Moody N. Y. E. C. Eckel

1 E. sirtalis *L.*, garter snake. Axton N. Y. H. D. Reed. Cornell University

1 E. saurita *L.*, ribbon snake. Ithaca N. Y. H. D. Reed. Cornell University

1 Natrix fasciata sipedon *L.*, water snake. Ithaca N. Y. H. D. Reed. Cornell University

2 Eutaenia sirtalis *L.*, garter snake. Long Island. T. Bean

1 Malaclemmys centrata *Latr.*, diamond-back terrapin. Colonel's island creek, Long Island. T. Bean

1 Pseudemys rubriventris *LeC.*, red-bellied terrapin, "slider." Swan river, Long Island. T. Bean

1 Cistudo carolina *L.*, box tortoise. Madison N. J.

BATRACHIA

Rana sylvatica *LeC.*, wood frog, eggs. Forbes Manor Bath-on-Hudson N. Y.

3 Rana sylvatica *LeC.*, wood frog, eggs. Kenwood, Albany N. Y.

1 R. clamitans *Lat.*, green frog. Kenwood, Albany N. Y.

6 R. pipiens *Sch.*, spotted frog. Kenwood, Albany N. Y.

2 Hyla versicolor *LeC.*, tree frog. Bayshore, L. I.

1 H. pickeringii *Hol.*, small tree frog. Shawnee lake, Pa.

16 Bufo lentiginosus *Shaw*, toad. Bayshore, L. I., and Karners N. Y.

6 Desmognathus ochrophaea *Cope*. Shawanese lake, Pa.

2 Plethodon glutinosus *Gr.*, blue-spotted salamander. Shawanese lake, Pa.

1 Spelerpes ruber *Dau.*, spotted newt. Madison N. J.

2 Plethodon cinereus *Gr.* Shawanese lake, Pa.

Amblystoma *sp.* eggs. Forbes Manor Bath-on-Hudson N. Y.

PISCES

2 Carcharias littoralis *Mit.*, sand shark, head and heart. Bayshore, L. I.

3 Galeus canis *Mit.*, dog shark, heads. Bayshore, L. I.

2 Opsanus tau *L.*, toadfish. Bayshore, L. I.

1 Echeneis naucrates *L.*, sucking fish. Bayshore, L. I.

1 Leirus perciformis *Mit.*, black rudderfish. Bayshore, L. I.

2 Stenotomus chrysops *L.*, scup, with crustacean parasite. Livoneca ovalis Har.

1 Tautoga onitis *L.*, tautog, with crustacean parasite. Bayshore, L. I.

5 Species, unidentified, parasitized. Bayshore, L. I.

15 Amphioxus lanceolatus *Yar.*, lancelet. Naples, Italy Collected by Dr F. B. Sumner

Dr T. Bean. On Long Island: 1 Prionotus evolans *L.*, southern striped gurnard

2 Kirtlandia laciniata *Sw.*, silverside

2 Trachinotus falcatus *L.*, round pompano

1 Ammodytes americanus *De Kay*, sand lance

65 Stolephorus mitchilli *C. and V.*

66 Menidia notata *Mit.*, common silverside

7 Eupomatus gibbosus *L.*, sunfish

13 Pseudopleuronectes americanus *Wal.*, winter flounder

4 Paralichthys dentatus *L.*, summer flounder

3 Achirus fasciatus *Lac.*, sole

2 Lophosetta maculata *Mit.*, windowpane

25 Scomber scombrus *L.*, common mackerel

19 Fundulus heteroclitus *L.*, common killifish

7 F. majalis *Wal.*, killifish

16 F. diaphanus *Le S.*

7 Opsanus tau *L.*, toadfish

8 Spheroides maculatus *B. and S.*, puffer

1 Hyporhamphus roberti *C. and V.*, halfbeak

20 Tylosurus marinus *B. and S.*, garfish, billfish

4 Menidia beryllina *Cope.*

11 Mugil curema *C. and V.*, white mullet

2 Siphostoma fuscum *Stor.*, common pipefish

9 Tautogolabrus adspersus *Wal.*, cunner

12 Apeltes quadracus *Mit.*

3 Cyprinodon variegatus *Lac.*

3 Lucania parva *B. and G.*

25 Pomatomus saltatrix *L.*, bluefish

28 Pomolobus pseudoharengus *Wil.*, alewife

5 Anguilla chrysypa *Raf.*, eel

32 Brevoortia tyrannus *Lat.*, menhaden

12 Mugil cephalus *L.*, striped mullet

15 Tautoga onitis *L.*, tautog
2 Morone americana *Gme.*, white perch
1 Decapterus punctatus *Agas.*, scad
1 Cynoscion regalis *B. and S.*, weakfish
1 Prionotus carolinus *L.*, sea robin
1 Stenotomus chrysops *L.*, scup
4 Gobiosoma bosci *Lac.*
1 Clupea harengus *L.*, common herring
2 Leiostomus xanthurus *Lat.*, spot
1 Stolephorus argyrophanus *C. and V.*
1 Trachurops crumenophthalmus *Bl.*, big-eyed scad
1 Raja erinacea *Mit.*, skate, egg
1 Palinurichthys perciformis *Mit.*, black rudder fish

INVERTEBRATES

10 Molgula manhattensis *Ver.*, sea squirt. Bayshore, L. I.
15 Botryllus gouldii *Ver.* Woods Hole Mass.
10 B. gouldii *Ver.* Bayshore, L. I.
5 Amaroecium constellatum *Ver.* Woods Hole Mass.
2 Amaroecium unidentified. Woods Hole Mass.
11 Balanoglossus *sp.* Point o'Woods, Fire Island N. Y.
1 Limax maximus *L.*, slug. Albany N. Y. Mr Benjamin Levison
7 Ilyanassa obsoleta *Stimp.*, egg cases. Bayshore, L. I.
4 Natica duplicata *Stimp.*, egg cases. Bayshore, L. I.
1 Crepidula fornicata *Lam.* Bayshore, L. I.
1 Anaplodactylus lentus *Wil.* Woods Hole Mass.
10 Species Araneida, undetermined. Bayshore, L. I.; Albany N. Y.
5 Species Phalangida, undetermined. Bayshore, L. I.; Madison, N. J.
3 Ostrea virginiana *Lis.*, oyster. Long Island. T. Bean
3 Mollusca unidentified. Long Island. T. Bean
37 Mollusca unidentified. Long Island. H. E. Swezey
6 Loligo pealei *LeS.*, squid. Long Island. H. E. Swezey
1 Leptosynapta girardii *Ver.* Fire Island N. Y.
1 Asterias vulgaris *Stimp.*, starfish. Woods Hole Mass.
5 Arbacea punctulata *Gray*, sea urchin. Woods Hole Mass.

8 Echinarachinus parma *Gray*, sea urchin. Water island, N. Y. H. E. Swezey

5 Ophiopholis aculeata Gray, brittle stars. Water island, N. Y. H. E. Swezey

2 Holothuridia *sp.*, sea cucumber. Water island, N. Y. H. E. Swezey

20 Nereis virens *Sars.*, sand worm. Cold Spring Harbor, L. I.

8 N. limbata *Ehl.*, small sand worm. Bayshore, L. I.

15 Lumbriconereis opalina *Ver.* Cold Spring Harbor, L. I.

8 Rhyncobolus americanus *Ver.* Cold Spring Harbor, L. I.

10 Clymenella torquata *Ver.* Point o'Woods, Fire Island N. Y.

2 Cistenides gouldii *Ver.*, case. Bayshore, L. I.

1 Diopatra cuprea Clap., case. Bayshore, L. I.

1 Hirudo *sp.* Leech. Shawanese lake, Pa.

4 Nephelis *sp.* Leech. Normanskill, Kenwood, Albany N. Y.

4 Lumbricus terrestris *L.*, earthworm. Kenwood, Albany N. Y.

Several species annelida still undetermined.

1 Spirobolus marginatus (Say). Shawanese lake, Pa.

1 Fontaria coriacea Koch. Shawanese lake, Pa. Pres. by Miss H. E. Troxell

1 Scutigera forceps *L.* Albany N. Y.

7 Lithobius *sp.*, centipede. Bayshore, L. I.

10 Lithobius *sp.*, centipede. Karners N. Y.

3 Julus coerulocinctus Wood, wireworm. Kenwood, Albany N. Y.

Several species as yet undetermined. Bayshore, L. I.; Albany co. N. Y.; Madison N. J.

55 Branchipus vernalis. Van Cortland park, N. Y.

5 Apus cancriformis *Schaf.* Colorado. From department of zoology, Columbia University

15 Specimens of several species of Eucopepoda parasites. Bayshore, L. I.

4 Lepas fascicularis *E. and S.*, Goose barnacle. Fire Island N. Y.

2 L. fascicularis *E. and S.*, Goose barnacle. Bayshore, L. I.

1 L. fascicularis *E. and S.*, Goose barnacle. Meadow point, L. I. T. Bean

3 Chelonobia testudinaria *L.*, barnacle from loggerhead turtle. Long Island. T. Bean

56 Talorchestia megalophthalmia Sm., sand flea. Point o'Woods, Fire Island N. Y. Miss J. H. Cutler

5 Talorchestia longicornis Sm.

65 Gammarus etc. *sp.* Bayshore, L. I.

21 Caprella geometrica *Say.* Bayshore, L. I.

35 Caprella geometrica. Water island, N. Y. H. E. Swezey

5 Idotea irrorata. Bayshore, L. I.

8 Livoneca ovalis Har. Bayshore, L. I.

5 Bopyrus palaemoneticola Pack, parasite on shrimp

18 Armadillidum vulgare *Lat.* pill bug. Bayshore, L. I.

10 Oniscus asellus Linn. *sp.* sow bug. Bayshore, L. I.

2 Palaemonetes vulgaris *Stimp.*, shrimp. Long Island. T. Bean

25 Palaemonetes vulgaris *Stimp.*, shrimp. Bayshore, L. I.

1 Crangon vulgaris *Fab.*, sand shrimp. Long Island. T. Bean

55 Viribus zostericola *Sm.*, Bayshore, L. I.

1 Peneus braziliensis *Lat.*, southern shrimp. Bayshore, L. I. G. G. Scott

6 Cambarus immunis Hagen. Rensselaer lake, Albany co. N. Y.

2 Cambarus bartonii Fab., Van Cortland park, New York city

14 Eupagurus longicarpus *Stimp.*, hermit crab. Bayshore, L. I.

2 E. longicarpus *Stimp.*, hermit crab. Long Island. H. E. Swezey

105 Panopeus depressus *Sm.*, mud crab. Bayshore, L. I.

1 Callinectes hastatus *Ord.*, blue crab with deformed claw. Long Island. T. Bean

3 Platyonichus ocellatus *Lat.*, lady crab. Bayshore, L. I.

3 Cancer borealis *Stimp.*, northern crab. Marthas Vineyard, Mass.

1 Carcinus granulatus *Say.*, green crab. Woods Hole Mass.
1 Gelasimus minax *LeC.*, fiddler crab. Bayshore, L. I.
1 Pinnotheres ostreum *Say.*, oyster crab. Long Island. H. E. Swezey

A number of specimens of species still unidentified

6 Bugula turrita *Ver.* Bayshore, L. I.
1 Ascaris megalocephala *Clog.*, parasite of horse. Waterford N. Y.
1 Eudendrium racemosum *Ehr.* Department of zoology, Columbia University
7 Sagartia pustulata *McM.*, sea anemone. Bayshore, L. I.
3 Edwardsia *sp.* " Bayshore, L. I.
16 Dactylometra quinquecirra *Agas.*, jellyfish. Bayshore, L. I.
1 Cyanea arctica *F. and L.* " Bayshore, L. I.
1 Zygodactyla groenlandica *Agas.* " Bayshore, L. I.

Hydroids from Bayshore and Woods Hole, still undetermined

2 Cliona sulphurea *Ver.*, boring sponge. Bayshore, L. I.
1 Microciona prolifera *Ver.*, Bayshore, L. I.
3 Spongilla *sp.*, fresh-water sponge. Normanskill, Kenwood, Albany N. Y.

Ethnology

Purchases

Mrs Harriet Maxwell Converse. Cradle board on which General Ely Parker,[1] the Seneca sachem, Do-Ne-Ho-Ga-Wa, was strapped when he was born and on which he was carried till he had outgrown it. It is supposed to be more than 100 years old. 1 beaded strap accompanying the above cradle board.

Luke I. Fitch. 4 strings of wampum, 2 strings beads, 1 bone dagger, 1 string bone ornaments (all from Onondaga county).

———. 1 stone pestle, Fort Plain, Montgomery co.

Donation

Mr Bromime Copeland, Salem N. Y. 1 pair of old spectacles.

---

[1] General Parker was General Grant's military secretary during the Civil war and afterward commissioner of Indian affairs.

INDEX

University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director
JOHN M. CLARKE State paleontologist

Bulletin 49 December 1901

PALEONTOLOGIC PAPERS 2

Plate A

Photo by G. Van Ingen

Rysedorph hill; seen from the west. v v indicate outcrops

University of the State of New York

New York State Museum

Frederick J. H. Merrill *Director*
John M. Clarke *State paleontologist*

Bulletin 49 December 1901

PALEONTOLOGIC PAPERS 2

TRENTON CONGLOMERATE OF RYSEDORPH HILL RENSSELAER CO. N. Y. AND ITS FAUNA

BY RUDOLF RUEDEMANN

INTRODUCTION

From the Rensselaer plateau, which lies on the east side of the Hudson river opposite Albany, and extends from the river plain to the foot of the Taconic mountains, rise a number of ridges trending in a north northeasterly direction. The first of these passes only about one mile east of the city of Rensselaer. It is broken into several hills which, standing out in bold relief from the plateau, are veritable landmarks and can be seen for a great distance on both sides of the river. One of the more conspicuous of these hills is known among the people of the neighborhood by the appropriate name, "The pinnacle." It can be seen from the streets of Albany and readily attracts attention by its steep slopes and its abrupt elevation above the plateau. On the northern brow of the hill projects a mass of very hard limestone conglomerate which, having evidently protected the underlying soft shales from the action of ice and weather, is in some measure the cause of the existence of the hill. A closer investigation of this conglomerate, combined with observations on conglomerate beds farther south in the strike of this bed, has revealed not only the presence of a very interesting fauna but also the notable fact that the pebbles composing this bed vary greatly in their

age. This conglomerate bed is intercalated in the so called Hudson river shales discussed in a previous paper and is thus of still farther interest in its bearing on the question of the age of those shales.

A perusal of the early literature of the New York geologic survey leaves no doubt that this same hill with the capping limestone conglomerate once played a very interesting and important role in the bitter struggle over the Taconic problem.

Dr Emmons was probably the first to notice the locality and collect its fossils; for Hall, in *Paleontology of New York*, 1:35, described among the Chazy fossils a cephalopod as Orthoceras bilineatum, and added:

> An examination of this specimen since the plate was engraved convinces me that it is identical with O. bilineatum of the Trenton limestone. This specimen was given me by Dr Emmons as coming from the Calciferous sandstone at a locality 2 miles east of the city of Albany. An examination of the spot has convinced me that the rock in question is the Trenton limestone thrust up through the Hudson river slates. The association of fossils as well as other circumstances prohibit its reference to the Calciferous sandrock.

Dr Emmons, in his endeavor to defend the Taconic system against the aggressions of nearly all his contemporaries, considered the stratigraphy of this locality as of special importance for the demonstration of his assertion that the Siluric beds lie unconformably on the Taconic. In his last defense of his cherished object of research, contained in *American geology*, 1855, pt 2, p. 72, a section of Rysedorph hill[1] is given, which is copied here with the following description of the stratigraphic relations.

> At the milldam, the blackish sandstones of the Hudson river dip also east; half a mile further sandstones again crop out, dipping steeply to the west. Just beyond, the green Taconic slates dipping e 10° s support a heavy mass of Calciferous sand-

1 Dr Emmons calls the hill Cantonment hill. Inquiries among the occupants of the neighboring farms brought out the fact that the next hill succeeding in southerly direction was formerly called Cantonment hill on account of a military encampment on it during the war of 1812, and this term has now been perverted into Catamount hill, the present name of that prominence; while the hill described by Dr Emmons passes now under various names, as Sugar Loaf hill, the Pinnacle, Rysedorph hill, etc. As the last name has been adopted on the topographic map of the U. S. geologic survey, it is retained in this paper, though no longer in popular use.

Plate B

Photo by G. Van Ingen

Rysedorph hill. Nearer view of outcrop of Trenton conglomerate

stone, *a*, and slaty Trenton limestone. Viewing the position of all the rocks, we find that there is an anticlinal axis running at the base of the ridge at *f*, supporting the limestone. The anticlinal is on the line of the great Hudson river fault. The limestone, which is the most important mass, rests unconformably upon the Taconic slates *bb*.

Dr Emmons hence regarded the slates composing the hill as belonging to his Taconic system, and the Siluric beds, which he insisted were Calciferous and Trenton,[1] as lying unconformably on the slates; while Hall, later relinquishing his first view of the upthrusting of the Trenton block, considered the limestone conglomerate to be interlaminated in the Hudson river series. This view is met by Emmons with the following pertinent remark:[2]

Now some paleontologists are willing to admit that a few fossils may go up from the Trenton into the Hudson river series, but I believe that this is the first time that a paleontologist is willing to transfer the whole of the Trenton limestone with all its contents into a higher group.

From a note in the description of the fossils in the cited work of Emmons it appears that this investigator insisted on the Calciferous age of the Orthoceras bilineatum described by Hall from that locality; for[3] it is added after the description, "Calciferous sandstone, Greenbush", and remarked, "Trenton limestone thrust up through the Hudson river slates!!" (the exclamation marks those of Emmons). And it is farther stated that the figure given by Hall of the O. bilineatum from Greenbush differs from specimens from the Trenton. It is insinuated that Hall identified the species as a Trenton form to avoid admitting the presence of the Calciferous sandstone, for "to admit the existence of the Calciferous sandstone below the Trenton at this place would be equivalent to the admission of the Taconic system."

---

1 Emmons recognized the derivation of the pebbles from several formations as is evident from his remarks on this locality in the *Agriculture of New York*. 1846. 1:57, where are cited as found by him in the limestone bed; Maclurea, Bellerophon bilobatus and "masses bearing the character of the Birdseye limestone" and it is concluded that "all these facts put together indicate that this mass of limestone is a mixture of all the lower limestones of the New York system; that they meet in this mass though it is by no means extensive."

2 Am. geology. 1855. pt 2, p. 72.

3 Am. geology. 1855. pt 2, p. 149.

Later, this locality was once more mentioned by Walcott in his paper on the Taconic question,[1] where the outcrop is considered a block of Trenton conglomerate caught on the line of the great fault which passes through the hill and which separates the Cambric and Siluric strata. In the light of the knowledge obtained by Ford and Walcott, it was evidently unfortunate that this locality with its complex relations became the object of contention between the early geologists; for, with similar shales, one of Cambric, the other of Siluric age, on opposite flanks of the hill, apparently without any fossils in the immediate neighborhood, the locality was apt to mislead both antagonists. As the writer has demonstrated elsewhere, the Hudson river shales on the east side of the Hudson river belong to the Normans kill zone of graptolite shales and are of Trenton age. Graptolites characteristic of this zone have been found at the western edge of the plateau in Rensselaer in a road metal quarry at the corner of High and 2d streets. The assumption of the intercalation of this supposed Trenton conglomerate in the shales which are of Trenton age, would, therefore, involve no serious incongruity; in fact, a conglomerate bed with the same fauna, the same kind of pebbles and matrix, has been observed by the writer a few miles farther south at the Moordener kill, intercalated in graptolite-bearing shales. The question whether the bed on Rysedorph hill is intercalated in the shales or is a block thrust up along a fault, is therefore, of no great theoretic importance for our investigation; but it may be stated that the appearance of the isolated bed, which seen from the top is folded on itself, is quite suggestive of its having been carried along the overthrust fault. Under this assumption, however, it is evident that the conglomerate block can not be far removed from its mother bed, and that the latter must be intercalated in the great mass of Normans kill shales at no great depth.[2]

---

[1] Am. jour. sci. 1888. 35 :319.

[2] A. S. Tiffany exhibited at the Washington (1891) and Rochester (1893) meetings of the Geological society of America some fossils from the Rysedorph hill outcrop and published his observations in a small separate paper. In this he considers the bed a Trenton limestone and cites the following fossils: Streptorhynchus filitextum Hall, Leptaena sericea Sow., Orthis dichotoma Hall, Strophomena alternata Con., S. alternistriata Hall, Asaphus gigas DeKay.

The intercalation of a similar bed in Normans kill graptolite shale, at Schodack Landing, 20 miles farther south, was made known by S. W. Ford.[1] He describes it as being 2 feet thick, and in part, somewhat brecciated in appearance. From the mode of occurrence of this bed, he has no doubt that it is a regular member of the slate formation. It furnished to him: Isotelus gigas, Calymmene senaria, Dalmanella testudinaria, Platystrophia biforata var. lynx, Plectambonites sericea, Rafinesquina alternata, and the hemispheric variety of Chaetetes lycoperdon. Both the limestone and its associated graptolitic slates represent, in his estimation, the Hudson river group. A visit to this interesting locality, which lies in the direct strike of the Rysedorph hill and Moordener kill outcrops, convinced the writer that it is a third exposure of the same conglomerate bed, containing the same groups of pebbles, though in different relative quantities. A fourth exposure of the same conglomerate, observed by Ford just south of Schodack Landing in a ravine, running along the Columbia county line was not found again and is probably covered at present by alluvial deposits. Still another outcrop occurs near the boathouse of the Mohican canoe club, on Papskanee island between Albany and Castleton.

In all three localities the matrix consists of a dark gray to black arenaceous limestone, which weathers into a drab sandstone, the Calciferous sandrock of Emmons. At the Moordener kill it has a strong admixture of mud and also an admixture of numerous fragments of shale, which, however, may have been forced into it from the surrounding rock during the folding of the beds. The pebbles, which by lithologic and faunistic differences can be divided into seven groups, are irregularly mixed, mostly well worn, and of very different size; the latter characteristic in some measure depending on the hardness of the rock. The seven groups of pebbles are:

1 Lower Cambric limestone, represented by a single pebble found in the Rysedorph hill conglomerate, which is in lithologic

[1] Am. jour. sci. 1884. 28:207.

appearance identical with the lower Cambric conglomerate limestone of Troy and contains Hyolithellus micans Billings, a characteristic fossil of that locality.

2 Pebbles of nonfossiliferous grayish and reddish sandstones which may represent in age the Potsdam sandstone or Beekmantown limestone beds, or may be derived from sandstone beds in the underlying Normans kill graptolite shale. They are the strongly prevailing class of pebbles at Schodack Landing, have diminished in number at the Moordener kill, though still outnumbering the limestone pebbles, and are greatly reduced in relative quantity farther north, on Rysedorph hill.

3 Pebbles of a black, hard limestone, which appears crystalline by the profuse admixture of crystallized cystid plates. This class, which is represented by only a few pebbles found on Rysedorph hill, is similar in lithologic appearance to the Chazy limestone as exposed near Valcour on Lake Champlain. It has been found to contain Bolboporites americanus Billings, a characteristic Chazy fossil (see p. 11) and Paleocystites tenuiradiatus Hall.

4 The Lowville limestone is represented by hard, bluish gray pebbles with numerous birdseyes, Phytopsis tubulosa Hall, which differ in nothing from the Lowville limestone beds as exposed along the Mohawk and Black river valleys. At the Moordener kill also Tetradium cellulosum Hall sp., a characteristic fossil of the Lowville limestone, has been collected. The pebbles of this group, though not prevailing in any of the localities, are the most striking by their color, and in size they far surpass all others. At Schodack Landing boulders of a foot and a half in diameter have been observed. Opposite the railroad station, in the conglomerate of the rocky wall behind the village, they can be noticed from the car windows. At the Moordener kill boulders a foot in diameter occur. Their large size is evidently due to their great hardness, for their relatively small number and strongly water worn rounded surface indicate their derivation from a more distant place. On Rysedorph hill only a few small pebbles were found.

5 This group consists of mostly small pebbles of a very hard, compact limestone, intensely black when fresh, but very soft and of brownish tint when weathered. These were found in the conglomerate of Rysedorph hill and the Moordener kill, none being obtained at Schodack Landing. They contain a most interesting fauna, new and peculiar species of trilobites, brachiopods, and gastropods, described in another part of this paper. This limestone will be cited in the descriptions and lists as "compact black limestone."

6 Very commonly on Rysedorph hill and rarely also at the Moordener kill occur pebbles of a very hard, compact, fine grained, dark gray limestone, which weathers into a reddish gray rock, and therefore will be cited in this paper as the "compact, reddish gray limestone." It has been found to contain rarely a few of the fossils of the preceding limestone, while it never fails to contain ostracodes, some of the pebbles showing the tiny, black, glossy fossils with wonderful distinctness. The most common of these are Bythocypris cylindrica Hall, a variety of Schmidtella crassimarginata Ulrich, and Eurychilina reticulata Ulrich.

7 The last group of pebbles consists of a light gray crystalline limestone, which often changes into a veritable shell rock. The greater number of these is largely made up of Plectambonites sericea showing a varietal development, others consist of Rafinesquina alternata or parts of Isotelus gigas. This group of pebbles is by far the prevailing class in the Rysedorph hill conglomerate, and is still common at the Moordener kill, but has become greatly diminished at Schodack Landing, the relative quantity of these and the sandstone pebbles being, roughly stated, inversely proportional.

A farther discussion of the character and composition of this conglomerate bed can not be carried on advantageously till after the description of the species and the determination of the taxonomic relations of the faunas of the last three groups of pebbles.

The unmistakable presence of pebbles of Chazy limestone

(group 3) and the occurrence of such forms as Ampyx and Remopleurides in the limestone pebbles of groups 5 and 6 have been a cause of no little concern to the writer, lest a failure to separate the pebbles properly might cause a confusion of the faunas, specially as both groups consist of black limestone pebbles; special attention has therefore been paid to the association in the same pebbles of these new species with other well known fossils; and in the descriptions the most important associates have been mentioned. It has thus been found that nearly every pebble of groups, 5, 6, 7 were characterized by a typical Trenton form, removing thus the danger of a confusion with the Chazy limestone.

DESCRIPTION OF FAUNAS

ANTHOZOA

STREPTELASMA Hall

Streptelasma corniculum Hall. Pal. N. Y. 1847. 1:69

A number of specimens of a coral fully agreeing in external and internal characters with S t r e p t e l a s m a c o r n i c u l u m, were found in pebbles of black limestone of the Rysedorph hill and Moordener kill conglomerates, as well as in the matrix of the conglomerate at Schodack Landing. Several specimens represent the variety described by Hall as S t r e p t e l a s m a p a r v u l a. S t r e p t e l a s m a c o r n i c u l u m occurs in the Trenton, from Baffin Land[1] over Canada and New York as far west as Minnesota, but does not seem to go either above or below that formation. (Group 5)

TETRADIUM Dana

Tetradium cellulosum Hall *sp.*

P h y t o p s i s c e l l u l o s u m Hall. Pal. N. Y. 1847. 1:39

This index fossil of the Lowville limestone was found in boulders of light gray limestone in the Moordener kill conglomerate, which in their lithologic appearance show no difference from the Lowville limestone of the Mohawk and Black river valleys. (Group 4)

[1] Schuchert. U. S. nat. mus. Proc. 1900. 22:154.

BOLBOPORITES Pander

Bolboporites americanus Billings. Can. nat. and geol. 1859. 4:429

Pl. 1, fig. 1

This North American representative of the Russian Lower Siluric genus Bolboporites is according to Billings characterized by "a solid hemispherical base surmounted by a conical projection which is celluliferous, the cells being about the size and shape of those of the common Stenopora fibrosa." Specimens collected in the Champlain region, about Valcour, where this organism is extremely common in certain beds, show that the celluliferous projection is somewhat variable and may be ellipsoidal as in the specimen figured. While the taxonomic position of this body appears to be still doubtful, its value as an index fossil for the Chazy period is determined by the fact that no other representative of this genus has thus far been found in beds of any other period. According to Brainerd and Seely it is restricted to the lower Chazy. Specimens of this species were found at Rysedorph hill in pebbles of a black, crystalline crinoidal limestone, associated with plates of Palaeocystites tenuiradiatus Billings, another characteristic Chazy fossil. (Group 3)

DIPLOGRAPTUS McCoy

Diplograptus foliaceus Murchison *sp.*

Graptolites foliaceus Murchison. Silurian system. 1839. p. 695

A few rhabdosomes of this widely distributed and long-lived species were found in the black limestone pebbles associated with Trenton fossils. (Group 5)

CLIMACOGRAPTUS Hall

Climacograptus scharenbergi Lapworth

Climacograptus scharenbergi Lapworth, in Armstrong, Young and Robertson's Catalogue of west Scottish fossils. 1876. p. 140

Pl. 3, fig. 1

Climacograptus scharenbergi, an easily recognized graptolite, was found by Lapworth to occur in the lower

and upper Dicellograptus shales of Canada, and is also not unfrequent in the lower Dicellograptus or Normans kill shales of New York. In the conglomerate of Rysedorph hill it was found embedded in black compact limestone, associated with Pterygometopus callicephalus, Ampyx hastatus, Callopora multitabulata. (Group 5)

CRINOIDEA

Joints of stems only are found to constitute some gray limestone pebbles of Rysedorph hill. (Group 7)

CYSTIDEA

Plates of Palaeocystites semiradiatus Billings were found in the crystalline, black Chazy limestone, and a few plates of a Glyptocystites in the compact, black Trenton limestone, associated with Illaenus americanus and species of Tretaspis. (Groups 3 and 5)

BRYOZOA

STOMATOPORA Bronn

Stomatopora inflata Hall *sp.*

Alecto inflata Hall. Pal. N. Y. 1847. 1:77

Pl. 1, fig. 2, 3

Zoaria of this pretty bryozoan were found to grow frequently on the cranidia and pygidia of Isotelus maximus in the black compact limestone; they show the characters of the species as first described by Hall and later more fully defined by Ulrich. A finely preserved group attached to a Rafinesquina deltoidea shows a remarkable variation from the typical expression of Stomatopora inflata in having the zooecia abruptly contracted, and the proximal end tubular and slender, thus closely approaching a form described by Ulrich as Stomatopora turgida from the upper beds of the "Hudson river group" at Wilmington Ill.; the difference between the two consisting in the more spheric shape of the inflated part in the Hudson river form and the more pyriform to cylindric development of the same part in the Rysedorph hill specimens (fig. 3). The lack of frequent branching is also common to both.

STICTOPORA Hall

Stictopora elegantula Hall. Pal. N. Y. 1847. 1:75

Small parts of a bryozoan were found, which, on account of their fragmentary character, do not permit an accurate determination, but their oval apertures with strongly raised margins, permit their comparison with Stictopora elegantula Hall. (Group 5)

CALLOPORA Hall

Callopora multitabulata Ulrich

Monotrypella multitabulata Ulrich. Geol. and nat. hist. sur. Minn. 14th an. rep't. 1886. p. 100.

Many of the compact black limestone pebbles are fairly filled with a branching, subcylindric bryozoan, the surface of which could not be observed, as no weathered surfaces were found; their sections, however, reveal their identity with Callopora multitabulata Ulrich. Ulrich reports this organism from the middle and upper Trenton of Minnesota, the Trenton of Kentucky, Tennessee, and as probably occurring at Ottawa Can. (Group 5)

PRASOPORA Nicholson & Etheridge jr

Prasopora simulatrix Ulrich, *var.* **orientalis** Ulrich. Geol. and nat. hist. sur. Minn. 1895. v. 3, pt 1, p. 246

In the black compact limestone pebbles of Rysedorph hill, a few of the large hemispheric bodies, so widely known from the Trenton under the designation Chaetetes lycoperdon Hall, were found. As pointed out by Nicholson, no definition of this species has ever been given by either Vanuxem or Hall, or any subsequent writer, which can be regarded as in any sense sufficient, while it is certain that this name has been applied by different writers to wholly different forms. As Vanuxem's figure, which gives the external form only, and Hall's figures, which evidently include many forms, are no satisfactory proof as to the species on which the name was founded, Nicholson proposes to drop it altogether; Ulrich concurs, adding: "It would not be difficult to show that since 1842 no less than one hundred distinguishable forms have been included under this indefinite general designation."

The form found at Rysedorph hill proved, by thin sections, to be a Prasopora, identical with Prasopora simulatrix Ulrich, and very probably representing his var. orientalis, which is common in the Trenton limestone of Trenton Falls and Ottawa. (Group 5)

BRACHIOPODA

SIPHONOTRETA de Verneuil

Siphonotreta minnesotensis Hall & Clarke. Pal. N. Y. 1892. v. 8, pt 1, p. 177

Pl. 1, fig. 4, 5

A single but well preserved pedicle valve of a species of Siphonotreta was found in a pebble of black compact limestone associated with cranidia of Pterygometopus callicephalus.

As only two species on this continent have thus far been referred to Siphonotreta, i. e. S. (?) micula McCoy from the Beekmantown horizon of Canada, and S. (?) minnesotensis Hall and Clarke, from the Stones river beds of Minnesota, and as our form agrees with the latter species in all important features, it seems advisable to refer this valve at present thereto. Of both of these species the pedicle valve is completely known, and, on this account, their relation to the European genus Siphonotreta is still doubtful. The specimen from Rysedorph hill supplies this desired information for Siphonotreta minnesotensis.

The pedicle valve found is broadly subovate in outline, depressed convex, with a straight, elevated, at first conic, but terminally cylindric beak, rising a little posteriorly of the center of the valve and extending beyond the cardinal margin. Beak perforated, foramen round and apical. Median part of shell depressed, lateral parts low, convex, increasing rapidly in slope toward the lateral margin. Surface of the umbonal region nearly smooth, with faint concentric wrinkles which rapidly increase in strength anteriorly. From the wrinkles proceed numerous straight, thin spines, which attain the full length of the shell, extending far beyond the anterior and lateral margins.

Dimensions. Length 3.9 mm, width 3.7 mm, hight 4 mm.

Horizon and locality. Black compact limestone pebble of conglomerate of Rysedorph hill.

Observations. In common with the only other pedicle valve of Siphonotreta minnesotensis known, this form has the depressed median region and the concentric wrinkles, while it differs in size and the relative length of the spines, the latter being much larger in the New York specimen. The importance of this difference can, with only the two pedicle valves known thus far, not be properly adjudged.

The interesting feature of the specimen from Rysedorph hill is that it shows distinctly the elevated conic beak with perforated apex, a feature distinctive of the genus Siphonotreta, as restricted and more properly defined by Hall and Clarke.[1] As remarked before, the other American specimens tentatively referred to this genus have not furnished sufficient data for their generic determination. The specimen from Rysedorph hill indicates that Siphonotreta minnesotensis is the first undoubted American representative of that peculiar, eminently lower Siluric genus, which is well represented in Europe and extends with but one species into the upper Siluric. (Group 5)

CRANIA Retzius

Crania cf. trentonensis Hall. Descriptions new species Crinoidea and other fossils. 1866. p. 12

In the black compact limestone of Rysedorph hill a small internal cast of a Crania was found, showing two deep divergent oval central muscle pits on the apex and a third shallow one below. As the internal parts of the Trenton species of Crania are not yet known, a closer comparison is not possible.

PHOLIDOPS Hall

Pholidops trentonensis Hall. N. Y. state cab. nat. hist. 24th an. rep't. 1872. p. 221

A single but finely preserved specimen with regular oval outline and strong lamellose growth lines was found in the compact

1 Pal. N. Y. 1892. v. 8, pt 1, p. 177.

black limestone of Rysedorph hill. The specimen is smaller by one half than the average specimens of Pholidops trentonensis; but, it being the only specimen found, a comparison with the variety Pholidops trentonensis var. minor Winchell and Schuchert, from the base of the Galena limestone at St Paul, is excluded. Judging from the drawing given of that form, the Rysedorph hill specimen shows the same slight truncation as the western form, which becomes more emphasized in Pholidops subtruncatus.

Hall does not give the exact horizon of his species, which was secured at Middleville, and Dr White and Prof. Prosser did not find the fossil in the sections of Trenton Falls and other localities along the West Canada creek; the western variety occurs in the Black river and lower Trenton beds. (Group 5)

RAFINESQUINA Hall & Clarke

Rafinesquina alternata (Emmons) Hall & Clarke

Leptaena alternata Emmons. Geol. of N. Y. Rep't on second district. 1842. p. 395

Pl. 2, fig. 1

Many pebbles of the gray crystalline limestone of Rysedorph hill are filled to the exclusion of other fossils with very large specimens of Rafinesquina alternata. The extreme size of a great number of specimens, combined with a remarkable extension of the cardinal region, constitutes a striking variation from the type, which becomes more emphasized in such Lorraine forms as Rafinesquina alternata loxorhytis Meek. Numerous other specimens are remarkable for the strong oblique corrugation of their cardinal regions. Several specimens of great gibbosity and thick shell were also found in the compact reddish gray, ostracode limestone of Rysedorph hill. Rafinesquina alternata is also of frequent occurrence in the matrix of the conglomerate at the Moordener kill and at Schodack Landing. This form ranges from the Chazy to the Lorraine beds and extends from Canada to Minnesota and Manitoba. (Group 7)

Rafinesquina deltoidea Conrad *var.* An. geol. rep't. 1838. p. 115

In the gray, crystalline limestone occurs a Rafinesquina, which, on account of certain peculiarities, is worthy of notice. While it has the outline of Rafinesquina deltoidea, it is more convex, holding in this feature an intermediate position between R. deltoidea and R. camerata, as figured by Hall, and it lacks the concentric wrinkles on the depressed convex central disk, usually occurring in both of these species. Its most striking feature, however, is the entire absence of the fine radiating striae between the coarse ones, having only about 15 prominent, equidistant striae on an otherwise smooth shell. In view, however, of the great variations of R. alternata and its allies, R. camerata and R. deltoidea, on account of which it is often difficult to even assign a normal form to any of these three species, it would seem unwarranted to give any importance to such a varietal difference, if it were not for the fact, that the whole fauna of the conglomerate differs in so many of its constituents from the other New York faunas, thereby giving also to such varietal differences a certain significance in the comparison of provincial faunas.

According to Hall the species abounds in the Trenton limestone at Trenton Falls and at Sugar river in Lewis county and is scarcely known to occur in the Champlain valley. Dr T. G. White found that it characterizes certain Middle Trenton beds at Trenton Falls, and that it also occurs in the Trenton of the Champlain valley. Winchell and Schuchert report it from the middle and upper Trenton and the Lorraine beds of localities in Minnesota and Wisconsin; and according to Davidson[1] it is widely distributed in the Caradoc of Great Britain and through corresponding beds of Norway and Russia. The latter statements, however, are questioned by Winchell and Schuchert, as the identity of the European and American forms is still doubtful. (Group 7)

[1] Monograph Brit. Sil. Brach. 1871. v. 3, pt 7, p. 292.

LEPTAENA Dalman

Leptaena rhomboidalis Wilckens. Nachricht von seltenen Versteinerungen. 1769. p. 77

Leptaena tenuistriata Hall. Pal. N. Y. 1847. 1:108

Specimens of this long-lived species were found to occur in the black as well as in the crystalline, gray and compact, reddish limestone pebbles; in the first quite frequently and in large typical specimens, in the latter two in smaller specimens with strong corrugations on the disk, abruptly inflected margin, and the extension of the hinge line forming rather long, acute ears. Leptaena rhomboidalis occurs as well in Europe as in America, and ranges here from the Trenton up into the Carbonic. (Groups 5, 6, 7)

PLECTAMBONITES Pander

Plectambonites sericeus Sowerby *sp.*

Leptaena sericea Sowerby, in Murchison's Silurian system. 1839. pl. 19

Large typical specimens occur occasionally in the black compact limestone pebbles. (Group 5)

Plectambonites sericeus Sowerby, *var.* **asper** James

Leptaena aspera James. Cin. quar. jour. sci. 1874. 1:151

Pl. 1, fig. 6, 7

A variety with distinct cardinal corrugations was cited by James in his list of the Cincinnati fossils as Leptaena aspera. Later, Meek[1] described and figured this variety, stating that it has a large and proportionally wide shell with a straighter anterior margin, and the area of its dorsal valve more inclined forward. A form which shows these characters, with constant strong corrugations, occurs in immense numbers or rather composes the greater number of pebbles of gray limestone at Rysedorph hill, the Moordener kill and Schodack Landing, and is also very common in the matrix at these localities. The corrugations are oblique, acute, sharply terminating, large at the cardinal extremities and decreasing in length toward the beak. As the specimens marked characteristically in this manner pre-

[1] Pal. Ohio 1873. 1:70.

vail, and specimens without the corrugations are only rarely observed in the gray limestone, these forms seem to represent a local and perhaps provincial variety and aid in indicating provincial differences in the Trenton faunas of New York. These varietal features, specially the strong corrugations, seem not to be of frequent occurrence in other places, for none are mentioned in the full descriptions of Leptaena sericea by Hall, Sardeson, Winchell and Schuchert. The collections of the state museum prove that such forms are occasionally, though rarely found in the Trenton of other parts of the state; and specimens found at the old Dudley observatory, Albany and at Green Island give evidence that in this region it passed also into the upper Utica beds. In the latter localities it is frequently intermingled with typical specimens and can therefore hardly be considered a different species. (Cement and group 7)

Plectambonites pisum *sp. nov.*

Pl. 1, fig. 8–20

There occurs rarely in the gray crystalline limestone, and very profusely in the black compact limestone, a small, extremely gibbous species of Plectambonites which may be described as P. pisum.

Diagnosis. Shell small, semicircular in outline, with subauriculate cardinal extensions; highly concavo-convex, the convexity surpassing that of a hemisphere; toward the cardinal ears becoming depressed convex; length to width as 4:5, greatest width along the hinge line, which is nearly straight. Surface marked with very fine striae, which usually are interrupted by from 16 to 20 coarse striae; sometimes the fine striae become nearly obsolete, leaving the interspace between the coarse striae almost smooth; at other times the coarse striae disappear, leaving the shell uniformly and finely striated; a few concentric growth lines are also present. Pedicle valve extremely gibbous, the greatest elevation being in the central part; the umbonal part sloping abruptly; the umbo being protuberant and projecting beyond the cardinal line; anterior and lateral slopes less abrupt,

near the margins turning suddenly into a flatter border. Cardinal area moderately elevated, concave, delthyrium large, of equal width and length; no deltidium observed. Teeth small, supported by strong, diverging dental lamellae, which continue in outward direction into the much elevated margin of the diductor muscles; this margin extends about one fourth the length of the valve, and then returns under an acute angle including a very deep pyriform muscle pit. The muscle margins are separated by a distinct septum, which extends to near the anterior margin; from the anterior part of the muscular impressions extend strongly marked vascular trunks which are tri- or quadripartite and inclose between them a narrow elongate depressed area. Brachial valve concave in the middle part, closely following the curvature of the pedicle valve, with a well defined ridge all around the lateral and anterior margin. Cardinal area as high as that of the pedicle valve and also slightly concave, retrorse, with a large chilidium, somewhat concave in the middle. Cardinal process single and erect and, by its coalescence with the divergent, short, crural plates, appearing distinctly trilobate at its posterior end, similarly to P. sericeus, with the difference, however, that the posterior ends of the crural plates are not closely appressed to the cardinal process, but separate again a little, forming processes almost as prominent as and parallel to the cardinal process (pl. 1, fig. 18). Adductor scars shallow, broadly triangular, extending not quite to the middle of the shell, slightly divergent, inner margins formed by two ridges, branching from the crural processes and extending to near the anterior margin; outer somewhat indented margin of the muscular impressions greatly elevated as in P. gibbosus Winchell and Schuchert.

Dimensions. Length 8.5 mm, width 10.2 mm, hight 5.5 mm.

Horizon and locality. Extremely common in the pebbles of compact black limestone in the conglomerates of Rysedorph hill and Moordener kill, rare in the matrix and very rare in the gray crystalline limestone pebbles. (Groups 5, 7 and matrix)

Observations. From P. sericeus this form differs in the shape of the valves and their internal characters, no transitions being found between the two. In outline it approaches more the P. transversalis of the upper Siluric, specially in the projection of the umbo beyond the cardinal line and in the rounded cardinal ears, but it has quite different muscle scars in the brachial valve. It also shows a certain similarity to Leptella decipiens Billings, from the Beekmantown horizon of Quebec; it differs from that form, however, in being more convex and by its internal characters. Its nearest relation is undoubtedly with P. gibbosus Winchell and Schuchert, from the middle Trenton of Minnesota, from which form it differs in its surface characters, having 16 to 18 coarser striae to the six or seven of the western form; in being still more gibbous and abruptly so in the central part; and in its outline, in having the umbo project beyond the cardinal line and possessing marked subauriculate cardinal extensions. Judging from the drawings the western form seems also to be less rounded and more subtriangular in outline. A small European form, which from the description and figures furnished by Davidson[1] is apparently related to our species, specially in the shape and relative size of the muscle impressions is Leptaena scissa Salter. It occurs in the Caradoc and Llandovery beds of Great Britain.

CHRISTIANIA Hall & Clarke

Christiania trentonensis *sp. nov.*

Pl. 2, fig. 2–6

The most interesting brachiopod of the fauna of the black compact limestone pebbles is a new species of the rare genus Christiania, thus far represented in North America only by a Helderbergian form.

Diagnosis. Shell small, convexo-concave, somewhat variable in shape, rotundo-quadrate to rotundo-rectangular, sides subparallel or slightly converging to the cardinal line; front rounded. Hinge line straight, only slightly shorter than the greatest

1 Foss. Brach. Pal. soc. 1861. v. 24, pt 3, no. 4, p. 325.

width of the valve in the middle part; cardinal extremities obtusely angular, having the appearance of flattened ears. Pedicle valve uniformly and strongly convex; umbo slightly projecting and very narrow, beak obscure. Cardinal area narrow (?); interior of pedicle valve not observed. Brachial valve strongly concave, beak hardly projecting beyond the long, straight hinge line. Cardinal extremities strongly developed, flat; area very small; cardinal process small, bipartite on its anterior face; the lobes being denticulate anteriorly with from three to five small denticles on each side. Crural plates very long and slightly divergent; the lower portion produced on each side as a strongly elevated wall with perpendicular sides extending in the original direction of the crural plates close to the ante-lateral angle, where it recurves and returns, parallel to the median axis and nearly in a straight line as a still more prominent wall merging into the base of the cardinal process. The elongate, symmetric, subrectangular spaces thus formed are each divided transversely by a vertical ridge about one third of the length of the valve from the cardinal line. The long narrow space between the inner muscular walls is also bounded anteriorly by a low, rounded, curving ridge and divided in the median line of the shell by a low, rounded, longitudinal ridge. The anterior half of the surface of the long anterior adductors is very rugose and radially striated.

The surface is covered with concentric lines of growth and radiating, quite widely separated, filiform striae with smooth, flat interspaces.

Dimensions. Length 9.7 mm, width 8.9 mm, hight 3.1 mm.

Horizon and locality. Rysedorph hill. The few specimens obtained, among them a finely weathered interior of a brachial valve, were found in the pebbles of black compact limestone, together with P l e c t a m b o n i t e s s e r i c e u s, P l e c t a m b o n i t e s p i s u m and O r t h i s t r i c e n a r i a. (Group 5)

Observations. The genus Christiania was proposed by Hall and Clarke for such species, formerly included in Leptaena, as differ

in the surface ornamentation, composition of the cardinal process, arrangement of the muscle scars, and specially in the great muscular scars and their high walls. Three species are cited as clearly referable to this genus, viz Christiania subquadrata Hall, from the Helderbergian (?) group of Tennessee, Christiania tenuicincta McCoy sp. from the upper Llandeilo and the Caradoc series of Great Britain, and Christiania oblonga Pander sp. from the lower Siluric beds of the vicinity of St Petersburg.

A comparison of our species with the descriptions and figures of these three species brings out the fact that it is more closely related to the two European lower Siluric species than to the American Devonic; for the general form, it seems, is of little value for a comparative study, as both the English and the Russian forms vary greatly between short, broad and elongate forms, as is fully demonstrated by the figures given by Davidson [1] and by Murchison, Verneuil, and Keyserling [2] and also by the writer's specimens. While, however the Devonic form has the cardinal angles rounder and little produced, the surface smooth or only marked by squamous growth lines and the external lateral wall of the anterior adductor muscle in the brachial valve inflected in front of the crural processes, the British and Trenton species have rather strongly developed cardinal extremities, and the Russian and the Trenton forms have the longitudinal surface striae in common, for Murchison, Verneuil, and Keyserling report that specimens occur which have a striation like Leptaena sericea. Judging from the figures given in the *Geologie de la Russie d'Europe* the external walls of the anterior adductor muscles in the Russian form are straight continuations of the crural processes as in the Trenton form. Perhaps, however, to the latter character no great importance should be attached, as Davidson figures a brachial valve of Christiania tenuicincta with just such straight lateral walls among the other valves with inflected lateral walls, such as the Devonic form has.

1 Monograph Brit. foss. Brach. Sil. suppl. 1883. v. 5, pt 2, pl. 12, fig. 17-21, and v. 7, no. 4, pl. 47, fig. 7-18.

2 Geol. de la Russie d'Europe etc. 1845. pl. 15, fig. 2a-f.

Among the Russian forms is figured a pedicle valve with depressed umbo and very convex pallial region, which is quite similar to our form. Taking all these facts into account, it appears that the internal characters will hardly furnish any points of difference between the forms, and that, when the general form and the exterior are compared, the Trenton form combines the cardinal extremities of the British with the striated surface of the Russian species.

TRIPLECIA Hall

Triplecia nucleus Hall

Atrypa nucleus Hall. Pal. N. Y. 1847. 1:138

A small Triplecia, evidently identical with Triplecia nucleus Hall, was found to be common in the gray crystalline limestone pebbles of the conglomerate; a few specimens were also obtained from the compact reddish limestone with ostracodes. Triplecia nucleus has thus far been found only in the middle Trenton of New York. (Groups 6, 7)

ORTHIS Dalman

Orthis tricenaria Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:333

Orthis tricenaria occurs quite frequently in typical specimens of somewhat smaller size than those from the western side of the Adirondacks, in the gray crystalline and compact black limestone pebbles and in the cement. Its similarity to the Chazy form, Orthis costalis, together with the occurrence of numerous cranidia and pygidia of Ampyx and Remopleurides in the compact black limestone was at the first collecting quite suggestive of the Chazy age of the compact black limestone pebbles; a suggestion, however, which the common occurrence of typical Trenton fossils in the same pebbles proved to be misleading. (Cement and groups 5, 6)

Orthis tricenaria is reported by Hall from the lower Trenton of Middleville; in the west it ranges from the Stones river (Lowville) beds through the Black river beds into the Trenton. Dr White did not locate it in the Trenton and Rathbone brook sections.

PLECTORTHIS Hall & Clarke

Plectorthis plicatella Hall

Orthis plicatella Hall. Pal. N. Y. 1847. 1:122

Several large specimens of this species were found in the gray crystalline limestone pebbles. Hall reports the form as very rare in the lower Trenton of New York, while in the west it is common from the upper Trenton to the Lorraine beds. It has lately been found to ascend into the upper Utica beds in the vicinity of Albany. (Group 7)

PLATYSTROPHIA King

Platystrophia biforata Schlotheim *sp.*

Terebratulites biforatus Schlotheim. Petrefactenkunde. 1820. p. 265

With one exception all specimens of Platystrophia biforata, which is quite common in the compact black limestone pebbles, are only middle-sized, have rounded cardinal angles and only five to six not very strongly developed plications on either side of fold and sinus, while the usual number is from 12 to 16 plications on either side, and at least 12 in Trenton specimens of the same size from New York. As Winchell and Schuchert[1] state that the earliest individuals of this species, which ranges from the Chazy to the Niagara formation, are small in size and have but few and simple costae, characters which also appear in the young individuals, the immature characters of the specimens collected at Rysedorph hill point to a rather early age for the black limestone. (Group 5)

DALMANELLA Hall & Clarke

Dalmanella testudinaria Dalman *sp.*

Orthis testudinaria Dalman. Kongl. Svenska. vet. akad. Handl. for 1827. 1828. p. 115

Dalmanella testudinaria is very common in the gray and black compact limestone pebbles of Rysedorph hill, Moordener hill and Schodack Landing. (Groups 5, 7)

1 Geol. Minn. Pal. 1897. v. 3, pt 2, p. 456.

Dalmanella subaequata Conrad, *var.* **pervetus** Conrad

Orthis perveta Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:333

In the gray crystalline limestone, valves of a Dalmanella were found, which on account of their rather broad form, somewhat ventricose valves with a broad distinct sinus in the pedicle valve, and numerous thin bifurcating striae, have been referred to the group of Dalmanella subaequata. Winchell and Schuchert suggest that only the variety pervetus of Dalmanella subaequata occurs in New York and Canada. In the strong development of their somewhat angular sinus, in the character of the striae, which are a little coarser than the figures of Dalmanella subaequata would indicate, all the writer's specimens agree better with that variety, though they are of slightly larger size than the measurements and figures given by Conrad and Hall require, and in this regard corresponding better with the specimens figured by Winchell and Schuchert. Dr White reports D. subaequata from the Lower and Middle Trenton of the Trenton and Rathbone brook sections in New York. (Group 7)

PARASTROPHIA Hall & Clarke

Parastrophia hemiplicata Hall

Atrypa hemiplicata Hall. Pal. N. Y. 1847. 1:144

Parastrophia hemiplicata was found in the gray crystalline limestone in a few rather gibbous specimens with not very strongly developed folds. This form, which has a wide geographic distribution, having been reported by Schuchert from Baffin Land and also from the northwest, is considered to be restricted to the Trenton, but it has been found in the upper Utica beds of the neighborhood of Albany, and is reported by White as marking a zone in the upper Black river beds near Boonville. (Group 7)

PROTOZYGA Hall & Clarke

Protozyga exigua Hall

Atrypa exigua Hall. Pal. N. Y. 1847. 1:141

This small form was found to be quite common in the pebbles of gray crystalline and compact reddish gray limestone. While

the specimens obtained agree in all essential features with the New York form, as originally described by Hall, showing also the extended cardinal line and the slight inflection of the brachial valve toward the cardinal extremities (features which are more distinctly shown in the figures given by Hall and Clarke[1]) it bears from three to four marginal folds on either side and on both valves, a character mentioned by Hall and Clarke and more distinctly shown in the specimens described as Zygospira aquila by Sardeson and as Hallina nicolleti by Winchell and Schuchert. Hall reports the form from the "central part of the Trenton limestone at Lowville and near Martinsburg, Lewis county". Of later collectors it is mentioned only by Dr White from the Black river beds at Boonville and the Black river, but not from the Trenton Falls or the West Canada creek sections. Hallina nicolleti is reported by Winchell and Schuchert from beds corresponding to the New York Lowville limestone and from the upper third of the Trenton limestone in Minnesota and Iowa. More extensive observation in this state may therefore show its range to extend from the Lowville limestone through the Black river beds into the Trenton. (Groups 6, 7)

ZYGOSPIRA Hall

Zygospira recurvirostris Hall

Atrypa recurvirostris Hall. Pal. N. Y. 1847. 1:140

Zygospira recurvirostris is not infrequently found in the pebbles of gray crystalline limestone in the Rysedorph hill conglomerate. The specimens obtained present no features distinguishing them from the typical material, with the possible exception that the sinus is rather weakly developed. Hall reports that this shell occurs in considerable numbers near the middle of the Trenton limestone near Martinsburg, Lewis co. and that it also has been seen at Lowville and Middleville. White found it in the Black river beds of the Rathbone brook section, as well as in various horizons of the Trenton Falls section. In Canada and in the west it rises from the Lowville beds into the Trenton. (Group 6)

[1] Pal. N. Y. 1892. v. 8, pt 1, pl. 54, fig. 47-48.

PELECYPODA

MODIOLOPSIS Hall

Modiolopsis aviculoides Hall. Pal. N. Y. 1847. 1:161

Two internal casts were found in the gray crystalline limestone which are referred with some doubt to Modiolopsis aviculoides Hall, a little known species with which they agree in the outline of their somewhat ventricose valves, oblique cardinal lines, prominent umbones, and pointed anterior extremity. Hall obtained his specimens from the shaly intercalated layers in the central part of the Trenton limestone at Middleville. (Group 7)

WHITELLA Ulrich

Whitella ventricosa Hall *sp.*

Edmondia ventricosa Hall. Pal. N. Y. 1847. 1:155

A single large specimen of this species was found in a pebble of black compact limestone. Edmondia ventricosa is said by Hall to occur in the central and higher part of the Trenton limestone at various localities of New York. White reports it also from the Black river beds of the Poland limekiln section. Its occurrence in the west is still doubtful. (Group 5)

CTENODONTA Salter

Ctenodonta ? *sp.*

A single cast of a lamellibranch was found on a black compact limestone pebble, which in its outline is suggestive of a Cleidophorus, but it lacks the preumbonal clavicle impression, and probably belongs to a Ctenodonta of the C. nasuta group. It is too incomplete to allow exact determination. (Group 5)

Ctenodonta *cf.* astartaeformis Salter

There were also found three specimens of a small Ctenodonta of the C. (Nucula) levata group, which are comparable to C. astartaeformis Salter, of the Canadian Trenton,[1] but, judging from the description and figure of that species, seem to differ from that by being wider anteriorly and having very strongly developed growth varices which give to their surface

[1] Can. organic remains. 1859. Decade 1, p. 39.

an undate appearance. This feature is shown by all specimens, and is, therefore, evidently quite constant. It constitutes a specific difference from other species of Ctenodonta, of which C. similis Ulrich, from the upper Lorraine beds of Minnesota, is evidently very similar in outline, character of beak, etc. to the form from Rysedorph hill. As, however, the internal characters have not been elucidated, the description of the species is properly deferred till more complete material can be obtained. (Group 5)

GASTROPODA

PROTOWARTHIA Ulrich

Protowarthia cancellata Hall *sp.*

Bellerophon bilobatus Hall *non* Sowerby. Pal. N. Y. 1847. 1:184

Bellerophon cancellatus Hall. Pal. N. Y. 1847. 1:307

The fossil referred by Hall to Bellerophon bilobatus Sowerby occurs quite frequently in well developed specimens in the black compact limestone pebbles. Ulrich, maintaining that the American and the European form are specifically distinct, doubts whether the latter occurs in America, though its name has entered so largely into the American geologic literature; and, as he believes that Hall's B. bilobatus from the Trenton and Lorraine beds is identical with the same author's B. cancellatus from the Lorraine, he applies the latter name to this important Trenton form, making it at the same time the type of a new genus. Some of the specimens of the Rysedorph hill conglomerate by their more angular beak and the outline of the apertural lobes approach forms which formerly were also referred to B. bilobatus, but have been separated by Ulrich as Protowarthia rectangularis.

Bellerophon bilobatus was known to Hall only from the Trenton, Utica and Lorraine beds of New York. It possesses the same range in Canada, while in the west it has been found to appear in the Black river beds and to rise above the Lorraine into the Richmond beds. (Group 5)

CONRADELLA Ulrich & Scofield

Conradella compressa Conrad *sp.*

Phragmolites compressus Conrad. An. geol. rep't. 1838. p. 119

A few specimens of this handsome and striking fossil were found in gray crystalline limestone pebbles of the Moordener kill conglomerate, and black compact limestone pebbles of the Rysedorph hill conglomerate. The specimens do not show any marked difference from the typical material of this species in the New York state museum, nor any approach to any of the western species of this genus described by Ulrich. In New York this form is known only from the Trenton limestone. (Groups 5, 7)

CARINAROPSIS Hall

Carinaropsis carinata Hall. Pal. N. Y. 1847. 1:183

In a pebble of compact black limestone of the Rysedorph hill conglomerate a large Carinaropsis was found associated with numerous cranidia of a Remopleurides, which in profile and outline, and specially in the largely expanded aperture, and the sudden contraction toward the small incurved apex fully agrees with Carinaropsis carinata Hall, slightly differing in that the carination becomes obsolete near the apertural margin. Several smaller specimens of this rare species were found in the gray crystalline limestone, and in the compact reddish gray limestone a large specimen with very sharply projecting carina and strong concentric corrugations around the aperture. Hall reports this species from the black compact limestone at Middleville and Trenton Falls; while later collectors of Trenton fossils in this state make no mention of it. In the west the genus is represented in the Trenton group by several other species. (Groups 5, 6, 7)

LOPHOSPIRA Whitfield

Lophospira bicincta Hall *sp.*

Murchisonia bicincta Hall. Pal. N. Y. 1847. 1:177

Several casts of large specimens showing distinctly three carinations on the last whorl and the bicarinate upper whorls,

characteristic of this species, were found in the gray crystalline limestone pebbles and in a pebble of compact black limestone. In New York this species is also known from the Trenton beds; in Canada, the west, and the Cincinnati region, it has, however, been found to have its inception in the Stones river beds (Lowville limestone) and to pass through the Black river beds. (Groups 5, 7)

Lophospira perangulata Hall *sp.*

Murchisonia perangulata Hall. Pal. N. Y. 1847. 1:179

In the gray crystalline limestone pebbles a number of internal casts were found, which in the angularity of their volutions can be compared only with Murchisonia perangulata Hall, first described from the Lowville (Birdseye) limestone and in a supposed variety also from the lower Trenton of Middleville. Ulrich and Scofield hold the opinion that the two forms, united by Hall under one specific designation, represent in reality two different species, and refer a form from the western Stones river group to the Lowville type of M. perangulata. While the specimens from the Rysedorph hill conglomerate are a little more slender than Hall's type specimen apparently was, they all agree in the apical angle with some of the specimens figured from the Stones river group, and it is thought that they come nearer to the Lowville than to the Trenton form. (Group 7)

LIOSPIRA Ulrich & Scofield

Liospira americana Billings *sp.*

Pl. 2, fig. 7

Pleurotomaria americana Billings. Can. nat. and geol. 1860. 5:164

Pleurotomaria lenticularis Emmons, Hall and others (*non* Sowerby)

In a pebble of black compact limestone collected at Rysedorph hill, a large gastropod, somewhat weathered on the surface was found, which in outline and profile fully agrees with the Trenton form described by Emmons and Hall as Pleurotomaria lenticularis, these authors regarding it identical with Sowerby's Trochus jenticularis. Billings, recognizing the dif-

ference between the American and the European forms, described the form as Pleurotomaria americana. As Ulrich has pointed out lately, some other of Billings's species have been currently referred to Pleurotomaria lenticularis, viz P. vitruvia and P. progne. Both of these, when only casts are at hand and the surface characters are obliterated, can still be distinguished from the large Liospira americana, as the same investigators have demonstrated, by the character of the umbilicus, Liospira vitruvia and americana having an open umbilicus, while that of Liospira progne is closed. Liospira vitruvia and americana can be distinguished in sections by the angular margins of the umbilicus and its flattened sides in the former; the margins and sides of Liospira americana being round. A drawing of a section of the Liospira found in the Rysedorph hill comglomerate has been given; it shows that by the character of its umbilicus it can be referred only to Liospira americana.

Mr Ulrich has separated such species as Pleurotomaria americana, which are distinguished by their sublenticular shell, low depressed spire, almost smooth surface and subrhomboidal volutions, as Liospira The section figured shows distinctly the subrhomboidal section of the volutions as well as the depressed conic form of the shell. The *Paleontology of New York*, v. 1, reports this species from various Trenton localities, stating that it is most common in the higher crystalline portions of the rock at Watertown. Dr White cites it also from the Black river beds at Rathbone and West Canada creeks, and Prosser and Cumings[1] also found a form, doubtfully referred to this species, in the Black river beds near Newport. In Canada, Tennessee and the Cincinnati region, it has, however, been found in beds corresponding in age to the Lowville limestone. Its geographic distribution is great, for it has been found at Silliman's Fossil Mount in Baffin Land, is reported by Dr Whiteaves[2] from the Trenton beds of Lake Winnipeg and occurs in Minnesota and Tennessee.

---

[1] N. Y. state geol. 15th an. rep't 1898. 1:631.

[2] Pal. fossils. 1897. v. 3, pt 3, p. 191.

Liospira subtilistriata Hall *sp.*

P l e u r o t o m a r i a s u b t i l i s t r i a t a Hall. Pal. N. Y. 1847. 1:172

This characteristic small, lenticular gastropod was found in great abundance in the gray limestone pebbles of Rysedorph hill. At the time of the publication of the first volume of the *Paleontology of New York* Hall knew this species only from the concretionary limestone near the base of the Trenton at Watertown. Dr White did not observe it in the Trenton Falls section and the other localities along the West Canada creek, nor has he reported it yet from the Lake Champlain region. As it is mentioned neither by Ulrich and Scofield from Minnesota and the western states nor by Dr Whiteaves from Lake Winnipeg, nor by Schuchert from Baffin Land, it is evidently a form of horizontally and vertically restricted distribution and quite probably of some taxonomic value, indicating a low Trenton horizon. (Group 7)

CLATHROSPIRA Ulrich & Scofield

Clathrospira subconica Hall *sp.*

P l e u r o t o m a r i a s u b c o n i c a Hall. Pal. N. Y. 1847. 1:174

A few small specimens showing the characteristics of this species well developed were obtained in the gray crystalline limestone pebbles. Hall, in describing the species, had specimens from the lower part of the Trenton limestone at Watertown and from the Lorraine shales at Turin and Pulaski. In Canada it occurs also in the Black river beds, and in the west it is found in the Stones river group.

Ulrich and Scofield have described a very similar western form, C. c o n i c a, which is considerably smaller than C. s u b c o n i c a, and hence is said to have often been confused with young specimens of that species. The specimens from Rysedorph hill, though also much smaller than the average specimens of C. s u b c o n i c a, failed to agree with C. c o n i c a in other differentials from C. s u b c o n i c a. (Group 7)

ECCYLIOPTERUS Remelé

Eccyliopterus spiralis *sp. nov.*

Pl. 2, fig. 9, 10

A species of Eccyliopterus found in a pebble of black compact limestone from the conglomerate of the Moordener kill and associated with cranidia of Pterygometopus callicephalus and with Plectambonites pisum differs from its three Trenton congeners in being very loosely coiled. It may therefore be described here as new, though as yet known only by a single somewhat imperfect specimen.

Whorls strongly evolute, lying nearly in the same plane, apparently not more than two in number; enlarging quite rapidly, more in hight than in width. Upper side of shell marked along the outer margin by a carina extending into the collar, characteristic of Eccyliopterus; upper side sloping concavely inward, outer side nearly vertical, slightly convex; under side strongly convex. The collar is only partially preserved, its hight and extent therefore unknown. Aperture nearly vertical to the plane of the shell, ovate. Faint close growth lines are noticeable on the under and outer side of the specimen.

Dimensions. Length 35.2 mm, greatest width of volution 9.4 mm, greatest hight 10.8 mm.

Observations. This species may be easily distinguished from Eccyliopterus (Ophileta) ottawensis Billings, from the Canadian Trenton; from E. (Ophileta) owenanus Meek and Worthen, from the Trenton of Minnesota, as well as from E. beloitensis Ulrich and Scofield, from the Stones river group of Wisconsin and Kentucky, by its evolute and loose instead of contiguous whorls. In this regard as well as in the section of the whorls it is more related to E. (Eccyliomphalus) volutatus Whitfield, from the Fort Cassin beds, from which it differs in having a straight mouth, and considerably more rapid enlargement of the volutions. (Group 5)

TROCHONEMA Salter

Trochonema umbilicatum Hall *sp.*

Pleurotomaria umbilicata Hall. Pal. N. Y. 1847. 1:175

A pebble of gray crystalline limestone from the Rysedorph hill conglomerate was found to be filled with specimens which in all essential features agree with the descriptions of Trochonema umbilicatum given by Hall, Salter, Ulrich and Scofield, with the slight exception that the space between the suture and the first carina is not as flat as in most specimens, but rather concave. The carinae are more distinct than in any specimen figured by Hall. This form possesses a great vertical range, from the Lowville limestone to the Lorraine beds, and wide geographic distribution, being reported from Baffin Land, Lake Winnipeg, New York and the Trenton of the Mississippi basin. (Group 7)

HOLOPEA Hall

Holopea paludiniformis Hall. Pal. N. Y. 1847. 1:171

A large internal cast of this rare species, of which Hall reports that he obtained only one specimen (also a cast) from the crystalline upper part of the Trenton limestone at Watertown, was found in a pebble of compact black limestone at Rysedorph hill. Our specimen differs slightly from the type in having the volutions a little less ventricose and in its umbilical perforation. The form is not mentioned by later collectors with the exception of Ulrich and Scofield, who have referred a species from the lower Trenton in Minnesota to this species. This also is said to have a small umbilical perforation. (Group 5)

CYRTOSPIRA Ulrich

Cyrtospira attenuata *sp. nov.*

Pl. 2, fig. 8

A single specimen of Subulites was found in the gray crystalline limestone, which by its strong curvature is of a striking appearance to the eye accustomed to the rigidly erect species of the New York forms of Subulites.

Diagnosis. Shell small, length 12 mm; consisting of about five volutions, the last one of which occupies three fifths of the entire length of the shell; the four apical volutions are nearly straight, but the body whorl is curved in such a way that the apertural side appears straight, while the opposite side forms in outline a regular arch, the hight of which, measured in the middle, is a little greater than the width of the shell. Apical angle 38°; greatest width of valve between one third and one fourth of the length.

Aperture not observed.

Ulrich has separated species in which the aperture exceeds one half the whole hight of the shell, the shell arcuate and the truncation of the lower extremity of the aperture not so apparent, from Subulites and united them under the new generic designation, Cyrtospira. Our species shows the first two generic characters of this new genus in a marked degree, and stronger than the type species, while the third, the character of the aperture, is not observable.

This species differs from other congeneric forms, notably from C. parvula Billings from the Black river beds, C. abbreviata Hall from the Trenton of New York, and the three species described from the western Stones river and Trenton beds, in its longer spire, more slender form and stronger curvature. (Group 7)

PTEROPODA

HYOLITHUS Eichwald (ORTHOTHECA Novák)

Hyolithus rhine *sp. nov.*

Pl. 2, fig. 12–15

Among the novel forms of the Rysedorph hill fauna is a specimen of Hyolithus, obtained from the reddish gray compact limestone.

Diagnosis. Form, an elongated triangular pyramid, tapering at an angle of 16°; transverse section broadly triangular; ventral face slightly convex; dorsal face roof shaped with subangular crest; sides toward the aperture very slightly convex, toward the apex, however, bearing a broad, shallow, longitudinal depres-

sion, occupying about half the width. Lateral angles subacutely angular. Aperture unknown, but judging from the closely crowded growth lines, which curve forward on the dorsal side more than on the ventral, the peristome can hardly have arched forward on the ventral side, but probably was more or less abruptly truncated (subgenus Orthotheca Novák) Operculum unknown.

Dimensions. Length 35 mm or more, width 10+ mm, hight 6.4+ mm.

Observations. Only one other species has been made known from the Trenton, Hyolithus baconi Whitfield[1]. The Rysedorph hill species differs from this in tapering less rapidly, having a more elevated dorsal side (according to the lateral view given of H. baconi), and the growth lines on the convex side arch forward instead of passing straight across. It is noteworthy that only two species of this genus have thus far been found in the rich Trenton faunas from various regions of the continent. The distribution of this genus in the American beds seems to furnish an instance of the intermittent appearance of a group of organisms; for Hall[2] cites no less than nine species from the Cambric and six from the Devonic beds, with only one species to fill the tremendous interval from the Potsdam to middle Devonic beds. Since Hall's publication the number of North American Cambric species has increased to 14, and that of the Devonic to 11, while one species has become known from the Chazy, one from the Trenton, one from the Lorraine, and one from the Niagara beds. Nor can it be held that one of the two subgenera into which the genus has been divided by Holm comprises the Cambric and the other the Devonic species, thus resolving the apparent twofold culmination of the genus into the culmination of two different successive groups of fossils. That the genus Hyolithus is also represented in other localities within this state becomes apparent from Dr White's investigations of the Trenton Falls section, whence he

1 Geol. Wis. 1882. 4:225.

2 Pal. N. Y. 1879. v. 5, pt 2, p. 197.

cites an undescribed species of Hyolithus from two horizons.[1] (Group 6)

HYOLITHELLUS Billings

Hyolithellus micans Billings. Can. nat. 2d ser. 1871. 4:215

Pl. 2, fig. 11

The highly characteristic internal cast of the operculum of this species, showing very distinctly the subcentral knob and the radiating elongate ovate scars and smooth margin, was found in a limestone pebble from Rysedorph hill, differing from the rest of the limestone pebbles in lithologic appearance. The specimen retains a part of the periderm and a fragment of the shell and this indicates, as the appearance of the limestone would suggest, that the lower Cambric conglomerate limestone of Troy, a few miles to the north, which contains this problematic fossil in considerable number, is very sparingly represented in the Rysedorph hill conglomerate. This older Cambric conglomerate has also been found by Ford at Schodack Landing, with Hyolithellus micans and other species, and has, therefore, a similar extension as the Trenton limestone conglomerate, with which it strikes parallel but farther east on the other side of the overthrust fault. As we shall presently observe, the Trenton conglomerate limestone is similar in other features to the Cambric limestone at Troy and indicates a repetition of the conditions of early Cambric time, in the lower Siluric of the same region. (Group 1)

CONULARIA Miller

Conularia *cf.* **trentonensis** Hall. Pal. N. Y. 1847. 1:222

A very young specimen of Conularia was found in a black limestone from the Moordener kill conglomerate. It shows only the transverse ridges; the direction and the strong development of these, however, are very suggestive of identity with Conularia trentonensis Hall. (Group 5)

[1] N. Y. acad. sci. Trans. 15:94.

CEPHALOPODA

SPYROCERAS Hyatt

Spyroceras bilineatum Hall *sp.*

Orthoceras bilineatum Hall. Pal. N. Y. 1847. 1:199, 300

Hall described and figured as Orthoceras bilineatum a shell which Dr Emmons had collected at Rysedorph hill. Whether the specimens have been found in the matrix or in the pebbles, and in which kind of the latter, can not now be established. The writer has not observed any specimens of this species in the conglomerates of the localities investigated.

Spyroceras *cf.* anellus Conrad *sp.*

Orthoceras anellus Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:334

In the gray crystalline limestone thin and very slightly tapering fragments of a cephalopod are found, which are characterized by sharply elevated, equidistant, longitudinal ridges with smooth interspaces. Forms with a like surface sculpture, but with much less rapidly tapering shells, have been described by Hall from the Beekmantown and Trenton beds as Orthoceras laqueatum. Dr Clarke has shown[1] that the shell of O. bilineatum is not annulated in the apical region, but is quite strongly marked by alternating longitudinal elevated lines, which as growth advances become finer, while strong annulations gradually develop. These features bring O. bilineatum under the genus Spyroceras of Hyatt. From this fact it seems probable that Hall's O. laqueatum is only the apical portion of a Spyroceras, probably O. bilineatum. The specimens from Rysedorph hill show only equal longitudinal ridges, but as they represent much younger growth stages than those observed by Clarke—they have a diameter of only 1 to 2 mm—it might be inferred that they also belong to Spyroceras bilineatum, and that the finer intercalated, longitudinal ridges develop only with later growth. This conclusion

[1]Geol. Minn. Pal. 1897. v. 3, pt 2, p. 786.

would seem to be supported by the finding of a specimen of S. bilineatum in the Rysedorph hill conglomerate by Dr Emmons. There are, however, some facts which combat such a view. These are the observations of Clarke; that the alternation of the striae is more distinct toward the apical region and by rapid intercalation becomes less pronounced toward the aperture; farther, that a shell of S. bilineatum, with a diameter of 7 mm, had only 12 lines of the first order, while the shells under consideration, with a diameter of only 3 mm, have already about 20 striae; that no trace of the fine transverse lines, appearing on all stages of S. bilineatum, has been observed thus far; and finally that the small shells of Rysedorph hill taper exceedingly slow, while those of S. bilineatum taper quite fast. A fragment ¾ inch long shows no measurable increase in diameter. Orthoceras anellus Conrad differs in just these features from O. bilineatum and it suggests itself that these shells, if not a new species, are very likely to be the apical portion of O. anellus, hitherto not observed, and also that O. anellus is a typical Spyroceras.

Spyroceras bilineatum has been found to range in the east (Canada) from the Black river into the Trenton beds, in the west to begin in the Stones river beds, and Spyroceras anellus begins in the Black river beds and extends into the Trenton. (Group 7)

(Cyrtoceras) subannulatum d'Orbigny *sp.* Prodr. de pal. 1850. 1:1

Cyrtoceras annulatum Hall. Pal. N. Y. 1847. 1:194

A fragmentary specimen characterized as belonging to Cyrtoceras annulatum by its strongly arcuate annulations, fine transverse lines and central tubular siphuncle, was found in a pebble of greenish gray compact limestone. This species was obtained by Hall from the lower and upper Trenton beds of New York. (Group 7)

ZITTELOCERAS Hyatt

Zitteloceras hallianum d'Orbigny *sp.*

Cyrtoceras hallianum d'Orbigny. Prodr. de pal. 1850. 1:1

Cyrtoceras lamellosum Hall. Pal. N. Y. 1847. 1:193

In the black limestone, fragments of Cyrtoceras hallianum were found with the undulating squamous lamellae characteristic of this species. Hall knew this species only from the lower part of the Trenton limestone at Middleville, and later collectors do not mention it. Dr Clarke reports it from the Black river beds of Wisconsin and Minnesota. (Group 5)

CRUSTACEA

TRETASPIS McCoy

Tretaspis reticulatus *sp. nov.*

Pl. 3, fig. 11, 15–20

Several pebbles of black compact limestone were found to be filled with a trinucleid, representing the genus Tretaspis which is new to this hemisphere. The specimens, about 20 of which were obtained, occur in association with Ampyx hastatus, Illaenus americanus, Ceraurus pleurexanthemus, Sphaercoryphe major, Cyphaspis and plates of a Glyptocystites.

Diagnosis. *Cranidium* subrectangular to semicircular in outline, the former in younger specimens; length to width as 3:8; frontal margin slightly rounded to nearly straight. Glabella pyriform with the anterior part spheric, abruptly widening and rising above the neck of the glabella; frontal part reaching to and slightly overhanging the frontal border; posterior part of glabella narrow, angular and provided with a median crest extending from the occipital ring to about the middle of the frontal lobe, where it ends with a tubercle. There are three pairs of deep pits or fossae; the first small, deep and round, well up the tumid part of the glabella; the second broad and oval extending obliquely forward from the dorsal furrow; the third deep, transverse impressions situated a little anteriorly of the occipital furrow.

Dorsal furrows distinct, broad and deep, narrowing forward and extending to the frontal border. Fixed cheeks slightly prominent, trapezoidal in outline, nearly flat in the middle part and bending rather abruptly into the dorsal furrow and to the marginal border; each cheek provided with an "eye line," which, arising in the dorsal furrow below the first glabellar pit, extends in the direction of the genal angle, culminating near the middle of the cheek in an eye tubercle and becoming then indistinct. Occipital furrow broad and shallow, widening on either side of the glabella. Occipital ring a uniformly narrow ridge which in the axial lobe rises to a semicircular plate (base of spine?).

Surface of glabella coarsely pitted; cheeks pitted along the border and strongly reticulate in the middle. The meshes of the reticulation are largest on the cheeks; dorsal furrows and occipital ring smooth. Marginal border in front of the glabella inclined to base at an angle varying between 80° and 90°, but becoming less inclined posteriorly; in front of the cheeks for about half of its width moderately convex, then equally concave with the margin upturned. The convex portion of the border in front of the glabella is occupied by four concentric rows of circular funnel-shaped perforations, which posteriorly increase by interplantation to seven or more rows; the concave portion bears a row of radiating elongated perforations[1]; the rows of perforations are separated by filiform, strongly projecting concentric ridges, which toward the genal angles become less distinct.

Free cheeks not observed.

Thorax not well preserved, apparently consisting of six segments, axis broad, moderately convex, decreasing in width more than one third; axial grooves shallow; pleurae not observed.

Pygidium roundish subtriangular, with an axis in a small specimen that is broad at the beginning, slightly tapering and ending bluntly; more acutely tapering in larger specimens; the small

---

[1] Dr D.-P. Oehlert has demonstrated in his valuable paper entitled: Sur les Trinucleus de l'Ouest de la France (Soc. géol. de France. Bul. 3e série. 1895. 23, p. 299) that the apparent perforations of the limb of Trinucleus are only the result of an unfavorable preservation; and that, in fact, the limb or doublure of Trinucleus is imperforate, but possesses cavities, produced by the invagination of the tegument of the limb. As the tegument mostly fails of perfect preservation, these double-conical cavities appear opened at their dorsal and ventral apexes.

specimen shows seven, the large nine annulations; only faint indications of pleural grooves on the nearly smooth, almost flat sides; margin beveled, concentrically striated.

Dimensions. Width of cranidium 13 mm, length 6 mm, greatest width of glabella 3.4 mm.

Horizon and locality. Nearly all specimens were obtained from two small pebbles of black compact limestone, where they were associated with Trenton fossils. (Group 5)

Observations. This species differs too obviously from the common Trinucleus concentricus and the similar Trinucleus bellulus to necessitate a long exposition of these differences; as most striking may be mentioned, the glabellar fossae, the tubercles, the eye line, the structure and profile of the marginal border, and the pitted reticulate surface of the cheeks and glabella. While this species differs so markedly from other American species, it shows the closest similarity to a group well known in Europe, the typical form of which is T. seticornis Hisinger, which in the fuller discussion given to this form and its characters by Nicholson and Etheridge[1] is shown to exhibit at the best only varietal differences from T. bucklandi Barrande. By Roemer and Frech the latter species is united with T. seticornis. This species is specially characterized by the presence of the glabellar pits, the apical tubercle on the glabella and the ocular tubercles, the eye lines, the deep dorsal furrow and the structure and profile of the marginal border.

McCoy repeatedly (1849, 1851) proposed the subdivision of the genus Trinucleus into two subdivisions—Trinucleus proper and Tretaspis McCoy, the latter characterized by "the presence of five thoracic segments, the furrows on each side of the base of the glabella, a diagonal line crossing the cheeks, approximately occupying the position of the facial suture and usually a small apical or culminating tubercle ocular (?) in character." This subdivision was adopted by Salter in 1857, who thus defines Tretaspis McCoy; "Ocular tubercle distinct; eye

[1] Monograph Sil. foss. Girvan district in Ayrshire. 1880. Fasciculus 2, p. 190.

line cutting the posterior margin, but the head not separated at the suture; glabella lobed." Barrande protested strongly and repeatedly against the subdivision, principally on the following grounds: the eye line is not a suture but only a single nervure, as is visible in many other Trilobites; and the five segmented thorax is of no account because of the metamorphosis undergone by Trinucleus. Nicholson and Etheridge, after the examination of a great number of specimens, fully concur with Barrande as to the unimportance of the number of the segments and the presence of the eye line, and therefore conclude, that Tretaspis as proposed by McCoy or Salter can not stand, but at the same time hold, that it may be advantageous to retain the term for that section of the genus Trinucleus which possesses a lobed glabella.

Beecher has shown (Am. jour. sci. 1895. 49:307) that Trinucleus concentricus, in its adolescent stage, possesses the features pointed out by McCoy and Salter as characteristic of the genus Tretaspis, and on this ground is inclined to reject McCoy's divisions of the genus Trinucleus, as Barrande did.

The cephala here described as those of Tretaspis clearly agree with the cephala of the young individuals of Trinucleus concentricus, figured in Beecher's excellent paper, in possessing the so called eye-lines and eye-tubercles. While, however, that investigator states that these features disappear when a width of 5 mm is attained, they are still distinctly preserved in the specimen figured on pl. 3, fig. 18, which has attained a width of 13 mm, that is, nearly the average size of the specimens of Trinucleus concentricus, and shows mature development of the border. Furthermore, the specimens from Rysedorph hill have the pitting which is so distinct in the stages figured by Beecher, and which also, as a very fine pitting, is still present on the mature Trinucleus concentricus, accentuated into a coarse reticulation. Also in the relatively small size of the glabella and the apparent absence of genal spines these specimens retain adolescent features. On the other hand they fail to show any indications of the triangular areas

marked off from the cheeks on each side of the glabella in the young of Trinucleus concentricus; and the lobation of the glabella which in adult specimens of T. concentricus has become entirely obscured, but is faintly shown on the young, is, in the specimens in the writer's hands, distinctly developed (*see* pl. 3, fig. 18). It is this feature on which Nicholson and Etheridge would base the genus Tretaspis.

The specimens from Rysedorph hill, therefore, not only retain features characteristic of the early stages of T. concentricus to a mature or approximately mature size, but have certain of these features, notably the lobation of the glabella and the ornamentation of the cheeks even more strongly developed than those young stages. There can, therefore, be hardly any doubt that this form represents a phylogenetic stage in the development of the Trinucleidae, that is preceding Trinucleus proper and partly repassed in the ontogeny of the latter. It seems to the writer to be in full accord with our modern conception of a genus to recognize this distinct stage by a separate generic term. The features characteristic of this genus are also apparent in Angelin's species, Trinucleus bucculentus, (tab. 41, fig. 1) and T. foveolatus, while his T. affinis shows all these characteristics without the glabellar furrow, but his suggestion, "*an potius status juvenilis Trinuclei seticornis?*" would relegate this species into that group. Our species agrees fully with T. (Tretaspis) seticornis Hisinger, in the following features: the outline, surface sculpture and lobation of the glabella, the details of the marginal border with the exception that in T. reticulatus it is not bent vertically downward at the sides but only at an angle of about 45°. No important difference appears in the development of the thorax and pygidium. The principal differences would, then, seem to lie in the crest on the glabella, the less rounded and less convex profile and more trapezoidal outline of the cheeks and their strongly reticulated surface. We notice however that Angelin figures a form as T. affinis

which, as he suggests, might represent the young of T. seticornis, and which, judging from his drawings (specially tab. 40, fig. 21) shows a similar coarsely pitted and reticulate surface and similar outline of the cheeks. From all of these species, congeneric with Tretaspis reticulata, our form differs not only in the strong reticulation, but also in the development of a carina on the glabella of which no mention is found in the descriptions, and no indication in the illustrations of these species.

Angelin[1] however figures a form, T. carinatus, which has a median carina, passing along the whole length of the glabella, and which also belongs to the subgenus Tretaspis a fact which serves to prove that this feature also was represented on the other side of the Atlantic basin, and, as T. carinatus is supposed to come from *regio Da*, both carinate forms are approximately homotaxial.

Trinucleus seticornis occurs in Scotland and Ireland in beds referred to the Caradoc age, in Sweden in *regio Da*, and in Bohemia, at a horizon which lies higher than that to which belong even the Normans kill shale beds, in which the conglomerate bed containing this fossil is intercalated. Our form is, hence, older than all its congeners with the exception of T. bucculentus, from *regio Bà*, Norvegiae, the species which differs most from the rest of the group.

Tretaspis diademata *sp. nov.*

Pl. 3, fig. 12, 13, 14

A specimen of Tretaspis which was found in a black limestone pebble associated with Tretaspis reticulata and Ampyx hastatus presents the general appearance of the former except that in the limb the perforations are not arranged concentrically, but radially and so closely set as to produce high radial ridges and furrows. In the specimen the limb is present only as an internal cast, and the perforations appear

[1] Lindström's 2d ed. 1878. pl. 34, fig. 3.

therefore on the crest of the ridges. At the genal angle the ridges become rather abruptly dissolved into a crowded irregular mass of perforations (tubercles in the cast). Other differences between this and the preceding species are the considerably less width and almost vertical position of the limb in the frontal region and the greater prominence of the cheeks. The cheeks and glabella are finely reticulate.

Dimensions. Width of cranidium 15 mm; length 5.8 mm; greatest width of glabella 3.1 mm.

Horizon and locality. Pebble of black limestone in Rysedorph hill conglomerate. (Group 5)

Observations. The writer was at first inclined to consider this form as only a variety of T. reticulata. As, however, forms differing from T. seticornis in the same development of the limb have been described from corresponding beds in Norway and Great Britain, it seems opportune to separate also this form, in order to emphasize the fact of the occurrence of this type together with that of T. reticulata in approximately homotaxial beds on this and the other side of the Atlantic. It is, however, to be noted that, both in T. seticornis and T. reticulata, the perforations show more prominent arrangement in concentric rows, and less distinct radial arrangement; hence these forms probably represent only diverging branches from the principal stock, the common and widespread T. seticornis in Europe and T. reticulata in America. Angelin's form T. foveolatus (pl. 41, fig. 2) is from Da Norvegiae, and described as follows: *T. capite subtiliter favoso, limbo radiato, fronte utrinque foveolis (?), apice subglobosa, punctis ordinariis majusculis.* In this form the radial arrangement of the perforations extends over the whole surface of the limb. A corresponding form occurs in the Llandeilo and Caradoc beds of Great Britain, and was first described by Murchison as Trinucleus fimbriatus (?); later its characters were elucidated more fully, and a complete specimen from the Llandeilo flags figured by Sedgwick and

McCoy[1]. A comparison of the description and figure with our specimen shows a close similarity in the two forms, the limb in both being apparently alike, even to the breaking up of the radial rows into irregular arrangement at the lateral angles. The principal difference between the two species seems to lie in the shape of the glabella, which in the Trenton form is highly convex, with a hemispheric frontal part and an abrupt contraction to a narrow ridge behind the same, as in T. reticulata.

The posterior part of the glabella and cheeks are not so well preserved as indicated by the drawing.

AMPYX Dalman

Subgenus LONCHODOMAS Angelin

Ampyx (Lonchodomas) hastatus *sp. nov.*

Pl. 3, fig. 1–10, 30

The black compact limestone pebbles contain in great abundance cranidia and pygidia of a new species of Ampyx in association with such Trenton fossils as Pterygometopus callicephalus.

Diagnosis. *Cranidium* hastate in appearance, terminal points of glabella and fixed cheeks falling approximately into the angles of a regular triangle. Glabella subrhombic, contracted anteriorly and posteriorly, most convex and widest near the middle; more than half of it projecting snoutlike from the remainder of the cranidium; carina (or in others only a flattened area) extending the whole length of the glabella. Two long elliptic depressions, beginning in the pits at the base of the glabella, directly in front of the neck furrow, extend at the foot of either slope of the glabella for about one fourth of its length; two others directed obliquely downward, lie at the anterior ends of the dorsal furrows at the point where glabella and fixed cheeks meet exteriorly; two more lie directly above the others and are parallel to the axis of the glabella. On casts of the glabella (pl. 3 fig. 7) two prominent, transversely elliptic elevations can be noticed directly in front of the neck ring. On the crust they

[1] Syn. of classif. of Brit. pal. foss. 1855. pl. 1 E, fig. 16.

appear faint projections. It is supposed that they represent muscle scars.

Rostrum very long, prismatic, with a subrhombic section, upper sides grooved; strongly bent upward. Fixed cheeks having the shape of slightly recurving cusps, moderately convex, sloping rather abruptly downward at the frontal margin and gently upward in front of the neck segment, lying ventrally with their frontal part below the middle of the glabella, where a narrow, flat, vertical rim is developed. A line which appears most distinctly in casts as a narrow ridge, passes from the posterolateral angle of the fixed cheek obliquely forward across the same in the direction of the anterior glabellar pits. This line, in its direction and extent, seems to be an exact homologue of the eye line of Tretaspis and other trilobites and probably indicates the former presence and situation of the eyes in this genus, of which only blind forms are known. Suture line beginning directly below the second pair of glabellar pits, at the end of the flat marginal rim, running first a short distance outward, then turning rather abruptly backward to a point near the neck furrow, where it again curves outward, intersecting the occipital ring in oblique direction. Free cheeks were not observed, but, from the direction of the suture line, it is supposed that they were rather small, subtriangular plates. Dorsal furrows strongly marked. Neck furrow slightly curved, faint, deeper toward the genal angles. Surface of cranidium entirely smooth.

Thorax not observed.

Pygidium broadly triangular; axis well defined, broad, occupying about one third of the width of the plate, tapering slightly and ending bluntly near the terminal point; depressed convex, highest in the middle. Rarely more than six annulations, indicated by faint transverse furrows. Pleurae level, smooth, without indications of pleural ribs, with a deep furrow running parallel to the anterior margin, nearly vertically beveled along the margins, the upper edge of the bevel with an acute linear rim, sides finely striated parallel to the margin.

Dimensions. Width of cranidium 14.2 mm, length to base of rostrum 7.5 mm, width of glabella 5.2 mm, width of largest pygidium 5.5 mm, length 2.5 mm, width of axis 1.8 mm.

Horizon and locality. In the black compact limestone pebbles of Trenton age, in the conglomerate of Ryserdorph hill. (Group 5, 6)

Observations. This form differs from the only other Trenton species, Ampyx americanus Safford and Vogdes,[1] in the large anterior extension of the glabella beyond the fixed cheeks, this being a longifront, the other a brevifront, using subdivisional terms proposed by the discoverer of Ampyx americanus, and in having a strongly convex glabella without the oblique furrows of the western Trenton form. Our species is much more similar to Ampyx halli Billings, from the Chazy limestone of Canada and Vermont, with which it has in common the elongate convex rather strongly carinate glabella and the shape of the neck segment, but from which it differs in having a relatively shorter glabella extending hardly beyond the fixed cheeks, and by the semioval pygidium with distinct pleurae. Ampyx normalis from the Canadian Quebec beds, has the fluted rostrum and the rounded glabellar pits, but differs from A. hastatus in its short glabella. The Rysedorph hill species is much more closely similar to Ampyx rostratus Sars (Ampyx sarsii Portlock) in general outline, keeled glabella, long rostrum, long corniform cheeks, and according to the detailed description by Pompecki,[2] the elliptic impression on either side of the base of the glabella, while it differs in having the cheeks relatively broader and less contracted in the anterior part, and the pygidium more rounded. This closely related form is described by Portlock (loc. cit. p. 258) from the fossiliferous schists of Tyrone (Ireland) which are regarded as older than the schists with Diplograptus pristis and Graptolithus sagittarius, corresponding to our Normans kill shales in which the conglomerate is interbedded. Angelin describes the same species from the "*regio Da Norvegiae prope Christiania et in monte Kinnekulle Vestrogothiae*"; and

[1] Acad. nat. sci. Phil. Proc. 1889. 4:166.

[2] Trilobiten fauna der Ost- und Westpreussischen Diluvialgeschiebe. 1890. p. 16.

Frech (tab. p. 77) gives as its habitat the *Knollenkalk* $\alpha\beta$ and $\alpha\delta$ which are synchronous with the Glenkiln shales (Normans kill shales) and the corresponding lower middle graptolite shales of Scania and of Norway. Another European form with carinate glabella is Lonchodomas carinatus, which however has a more elongate cranidium, and is found in another horizon (Chasmops-Kalk of Westrogothia) according to Remelé.

The subdivisions of Ampyx, proposed by Forbes and Angelin, have been fully discussed by Nicholson and Etheridge,[1] and lately by Vogdes.[2] To restate shortly a case repeatedly elucidated, the genus Ampyx proposed by Dalman was divided in 1849 by E. Forbes[3] into:

1 Ampyx (Dalman) proper, with the head long and five segments of the thorax.

2 Brachampyx Forbes, 1849, with the head short and round and six segments to the thorax.

Dr Angelin in 1854[4] proposed the subdivision of his family into three genera:

1 Lonchodomas Angelin, with a lanceolate glabella, terminating in an elongate prismatic spine. Type L. (Ampyx) rostratus Sars.

2 Ampyx Dalman, with an oval glabella, terminating in a round spine, and six thoracic segments. Type Ampyx costatus Broeck.

3 Raphiophorus Angelin, with an obovate glabella, having an abrupt apical spine, and five thoracic segments. Type R. setirostris Angelin.

It appears by a comparison of these subdivisions, that Angelin retained the term Ampyx for forms with six segments, and thus applied it in the sense of the originator of the term, Dalman, who described Ampyx as having six segments; while Forbes proposed his term, Brachampyx, for just such six segmented forms. Nicholson and Etheridge, therefore, seem

1 Monograph Sil. foss. Girvan district in Ayrshire. 1880. p. 178. ff.

2 Am. geol. 1898. 11:99.

3 Geol. sur. Gt. Br. Mem. Dec. 2, 1849. pt 10, p. 3.

4 Pal. Scandin. p. 80.

to be fully justified in adopting Angelin's subdivisions in preference of the older ones of Forbes, on the very reasonable ground that the section represented by the original name of the author should correspond as nearly as possible to that author's definition. These subdivisions have also been adopted by other European writers on lower Siluric trilobites. A. W. Vogdes arranges the genus in three sections, as follows: 1) Brevifrontes, type Ampyx nudus Murchison; 2) Longifrontes, type Ampyx nasutus Dalman; 3) Lonchodomas, type Lonchodomas domastus Angelin.

It is evident that the species from Rysedorph hill falls under the section Lonchodomas of Angelin and Vogdes.

One pygidium (pl. 3, fig. 30) proved by its mode of preservation to be of exceptional interest. The crust of the axis is so favorably broken away that a perfect cast of the inferior surface is exposed. This exhibits, rising from the perfectly smooth surface of the matrix, two series of paired elevations which must correspond to impressions on the under surface of the crust. The outer series consists of the larger elevations, which near the anterior margin are round, largest, but also least projecting, while toward the posterior end of the axis they become smaller, transversely oval, being directed obliquely outward and forward, and more elevated and distinct. Alternating with this series is another of small, round tubercles, and within this lies still a third series of small tubercles, one always lying opposite the second, fourth, sixth, etc. of the inner second series. Along the median line runs a slightly elevated ridge corresponding to a median furrow of the pygidium. In another pygidium, in which the removal of the crust brought to light a similar system of elevations, eight of these could be counted in the exterior series. On the anterior part of the axis the annulation is indicated by a few shallow transverse grooves. These fall between the inner tubercles, and hence the elevations correspond with the annulation and original segmentation of the pygidium.

A series of tubercles similar to the exterior series has been described and figured by Nicholson and Etheridge[1] from the

[1] Monograph Sil. foss. Girvan district in Ayrshire. 1880. Fasciculus 2, pl. 13, fig. 3.

pygidium of A. rostratus Sars. These authors describe the axis of the pygidium of that species as faintly segmented and with a row of tubercles on each side. As the English species is in all features very closely related to that from the Trenton, and the latter never shows any tubercles on the axis of the external crust, but only on the casts, the writer feels sure that Nicholson and Etheridge had only casts of the pygidium, and based their conclusions on these. These authors, however, figure on pl. 10, fig. 20, of the same fasciculus a pygidium of an Asaphus *sp. ind.*, the slender axis of which, though much weathered, exhibits what appears to be a series of depressions on each side. Here the weathering has evidently reached the depressions in the crust, to which the above mentioned tubercles correspond. Similar depressions have before been observed by Salter[1] of Asaphus tyrannus, and considered by him to be internal glands, a view which evidently is also held by Nicholson and Etheridge. The writer has also obtained a small pygidium of Isotelus maximus from the Rysedorph hill conglomerate, which by the removal of the crust exhibits a series of eight pairs of tubercles which are somewhat obliquely directed backward (pl. 4, fig. 1).

The only observation of which the writer is aware which has been made on such pits in this country is that by Hall and Clarke[2] on a pygidium of Proëtus folliceps of the Onondaga limestone. In that specimen two paired series of alternating elevations can be observed; all of the elevations are however obliquely elongate, the inner series consists of the larger elevations, and the innermost elevations lie apparently directly on the axial line and are not paired. The same authors observed similar, though not so distinctly preserved markings on the internal cast of a pygidium of Proëtus crassimarginatus from the Onondaga limestone of Ohio[3] and the paired marginal impressions

[1] Monograph. pl. 22, fig. 9.
[2] Pal. N. Y. 1888. 7:101, pl. 29, fig. 1.
[3] Pal. N. Y. 1888. v. 7, pl. 25, fig. 8.

through the translucent crust of a pygidium of Phacops cristata var. pipa.[1]

Hall and Clarke consider the pits to be "areas of insertion for somitic muscles, the marginal pair probably connected with the natatory appendages, the axial pair possibly attached to the branchial apparatus, or to the viscera. The function of the median pits upon alternate grooves is not understood." On the upper surface of the crust of the Devonic species no indications of these characters were found. The axis of the pygidium of Ampyx is usually perfectly smooth or only provided with two or three faint annulations on the anterior part. One species, however (pl. 3, fig. 10) possesses a broad elevation along the median line of the axis; the indications of annulations, which in this species extend well toward the posterior end of the axis, are more distinct on the sides of the axis, than on the median elevation; the extent of this elevation, falling approximately in the region without distinct muscle scars, and the more distinct annulations on the sides, which probably are caused by the presence of the muscle scars, are indications of the influence of the strain exerted by the muscles on the configuration of the external crust.

REMOPLEURIDES Portlock

Subgenus REMOPLEURIDES *s. str.*

Remopleurides tumidus *sp. nov.*

Pl. 4, fig. 2-4

Two cranidia found in a pebble of dark gray, reddish weathering limestone (ostracode bed) differ so materially from the next described, Remopleurides linguatus, a form of most profuse occurrence in the black compact limestone pebbles, that they can not be considered to represent merely a later growth stage of the more common smaller species, but evidently represent a different type.

Diagnosis. *Cranidium* broadly elliptic, longest diameter at the posterior third; the longer diameter to the shorter as 10:9, poste-

[1] Pal. N. Y. 1888. v. 7, pl. 8 A, fig. 15.

rior margin nearly straight, lateral margin only slightly convex and curving but little inward to the base of the broad frontal lobe, which has straight margins, tapers only slightly and has a nearly straight frontal edge. Glabella moderately and regularly convex, highest at base of frontal lobe, from which it slopes regularly to the posterior and lateral margins and falls abruptly forward. Frontal lobe about one third the length of the cranidium. Glabellar furrows probably indicated by two pairs of barely visible, low, broad undulations near the posterior lateral margin, but not by smooth lines. Palpebral lobes very narrow, abruptly bulbous at the posterior angle. Surface of the cranidium smooth to the unaided eye, but not glossy on account of the presence of a microscopically small granulation; no striae observable. Occipital ring rather broad and wide, partly exfoliated in the type specimen.

Dimensions. Width of cranidium 9.6 mm; length to base of frontal lobe 7.9 mm; hight 3.2 mm.

Horizon and locality. In the reddish gray hard limestone pebbles at Rysedorph hill. (Group 6)

Observations. The glabella of this form shows a slight similarity in outline to that of R. striatulus Walcott, from the upper third of the Trenton limestone; it differs, however, by the absence of the coarse tuberculation and the suppression of the glabellar furrows, of which at least one pair is distinguishable in that species by smooth lines.

The cranidium appears to be more closely related to Remopleurides colbii Portlock, from the Caradoc, than to any other congener, but has also some relationship to R. affinis Billings, from the Quebec group.

Salter proposed to subdivide Remopleurides into two sections: one without glabellar furrows and inflated glabella, for which Portlock's original term, Remopleurides, was retained, and one with glabellar furrows and flat glabella, for which Barrande's name, Caphyra, was proposed.

Subgenus CAPHYRA Barrande

Remopleurides (Caphyra) linguatus *sp. nov.*

Pl. 3, fig. 21–29

The heads and pygidia of this species were found abundantly in the black crystalline limestone in association with Ampyx hastatus, etc. and in a few specimens also in the gray crystalline and reddish gray compact limestone pebbles of Rysedorph hill conglomerate.

Diagnosis. *Cranidium* transversely elliptic, longest diameter at the posterior fourth; longer diameter to the shorter as 9:8; strongly curved at the sides, rapidly contracting to the base of the frontal lobe, and to the junction with the occipital ring; base of frontal lobe and base of cranidium having about the same width; nearly flat, with a slight broad longitudinal depression in front of the occipital furrow; turning abruptly downward at the base of the frontal lobe; the latter tonguelike, half the length of the entire cranidium, straight in very young specimens, bending downward at an angle of 80° to 90° in mature specimens; with straight parallel or sometimes somewhat diverging margins; gently rounded forward. Three pairs of glabellar furrows distinctly indicated by curved, smooth linear depressions extending from near the margin three fourths of the distance to the median longitudinal depression. Palpebral lobes narrow, terminating bulblike posteriorly, encircling the cranidium from the base of the glabellar lobe to the occipital ring. Occipital furrow deep and narrow; occipital ring slightly convex, depressed below the level of the cranidium, short. Surface of cranidium with very fine, somewhat wavy transverse striae and tubercles; the latter increasing in size toward the lateral and posterior margins; anterior third of occipital furrow smooth with a small central tubercle; behind this two transverse filiform ridges and very large tubercles, obscurely arranged in four transverse rows.

Eyes large, forming an elongate crescent-shaped, rather high, nearly perpendicular wall with very finely reticulate, depressed convex surface.

Free cheeks narrow, beginning in front of the eyes with a vertical, rudderlike doublure of the outer margin (fig. 27) horizontal part forming a narrow, flat border around the eyes, which, on account of the strong curvature of the eyes and the outward and backward direction of its exterior margin, rapidly widens posteriorly into a subtriangular, slightly convex plate. Outer margin depressed, smooth, inner margin forming an elevated ridge supporting the eyes. Genal spines long, narrow, nearly flat, acutely pointed. Surface of free cheeks marked by finer striae directed obliquely inward and backward, becoming coarser on the spine and parallel to it.

A thorax referred to the same species has the features of the axis mostly obliterated by weathering, while the pleurae, which were buried in rock, are well preserved. The axis was apparently broad, about three times the width of the pleurae, regularly tapering posteriorly to a small pygidial plate quite strongly arched. The pleurae, 10 of which are found on either side, indicating the presence of 10 body segments, are only slightly bent at the beginning, but become increasingly falcate posteriorly, directed backward and downward with the exterior half, provided on the forward edge close to the axis with a strong, projecting fulcral tubercle, the opposite point of the hinder edge of the preceding pleura being furnished with a corresponding deep notch, the margin of which is raised all around. The pleurae are flat, with an oblique furrow extending from the fulcral tubercle to the tip of the point, and separating the deeper posterior part from the somewhat higher anterior, obliquely striated portion.

Of the pygidium only a small roundish plate is observable.

Dimensions. Width of cranidium 5.7 mm, length to base of frontal lobe 4.5 mm; of frontal lobe 2.3 mm; length of thorax 10+ mm, width of thorax 11+ mm.

Horizon and locality. Very common in the black compact limestone pebbles, rare in the reddish gray and gray limestone pebbles of the Rysedorph hill conglomerate. (Groups 5, 6, 7)

Observations. This form is very similar to some other American species, viz Remopleurides canadensis Billings, from the Canadian Chazy beds, and to the only other Trenton congener, R. striatulus Walcott, from the upper third of the Trenton limestone. With both it has in common the tuberculated cranidium, the presence of three pairs of smooth linear glabellar furrows and the central tubercle on the occipital ring. From both of these it differs in having the cranidium considerably broader than long, a longer tongue-shaped frontal lobe, in possessing fine striae, besides the tubercles on the cranidium, and by the strong tuberculation of the posterior part of the occipital ring.

From R. striatulus it also differs in the structure of the pleurae, which are here provided with distinct fulcral tubercles and corresponding notches and an oblique furrow, while those of R. striatulus are described as simply flat. In these features it agrees strongly with the species described from the Caradoc beds of Ireland by Portlock (emended by Salter) as R. colbii, laterispinifer and dorsospinifer.

In several features it seems to justify its intermediate stratigraphic position between the Chazy and the upper Trenton forms. Thus it resembles the former (R. canadensis) by the great relative width of its cranidium, and the latter by the character of the glabellar furrows. But the species from Rysedorph hill is still more similar to an Irish form, R. tuberculatus, lately described by F. R. C. Reed[1] from the Tramore limestone of county Waterford. With this it has the great width of the cranidium, the shape and extension of the abruptly projecting frontal tongue, the sudden increase in width of the palpebral lobes and the tuberculation of cranidium and neck segment in common. The Irish form differs in size, being about twice as large as R. linguatus and in the uniformity of its tubercles. It is also said to have but two pairs of glabellar furrows; as, however, some specimens of the Rysedorph hill species show but two or even but one pair of glabellar furrows, it is quite probable that more complete material of the Irish species would also show the third pair of

[1] Quar. jour. geol. soc. 1899. 55:748.

furrows, and that this difference may easily be overestimated. It is of special interest that R. tuberculatus occurs in stages 2 and 3 of the Tramore limestone, which is said to underlie Glenkiln shales, homotaxial with the Normans kill graptolite shales.

There is still another European form which well bears a comparison with our fossil; this is Brachypleura sexlineata Angelin (pl. 9, fig. 13) which in relative length and width of glabella, character of eye lobes, specially at the posterior end, tuberculation of glabella and extent of glabellar furrows closely agrees with R. linguatus, while it differs in having a much narrower frontal glabellar lobe, and, judging from the drawing, in the absence of tuberculation on the neck ring. This species is from the limestone of the Kinnekulle in Vestrogothia.

ASAPHUS Brongniart

1 Subgenus ISOTELUS De Kay

Isotelus maximus Locke

2d an. rep't geol. sur. Ohio. 1838. p. 246

Cranidia, eyes, pygidia, hypostomata and large genal spines of this trilobite are extremely frequent in the gray crystalline limestone pebbles, in some parts so common as to exclude other fossils. They are less frequent in the black compact limestone pebbles and in the cement, and none has been found in the reddish gray limestone with ostracods. The numerous spines would indicate that the prevailing species is Isotelus maximus in distinction from Isotelus gigas, but, as Dr Clarke[1] has pointed out, the cheek spine in these asaphids is to be regarded rather as a character of immaturity, diminishing in size as the adult condition is approached, than as one of critical value for specific separation.

The presence of muscle scars in the pygidia of this species observed in material from Rysedorph hill, has already been mentioned. Isotelus maximus ranges from the Trenton into the Richmond beds; Isotelus gigas is reported from the Chazy of Canada. (Cement and groups 5, 7)

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p 701.

2 Subgenus GERASAPHES Clarke

Gerasaphes ulrichana Clarke. Geol. Minn. Pal. 1897. v. 3, pt 2, p. 710

In the reddish gray compact limestone a small pygidium of an asaphid was found, which possesses the broad and short form, broad, flat border, strong annulation of the axis and distinct pleural ribs with deep pleural grooves of the pygidium, referred by Dr Clarke, on account of its presenting characters of the earlier representatives of the Asaphus stock at the time of the decline of the race, together with the presence, in other parts, of strong corresponding gerontic characters, to a new genus, Gerasaphes, and described as the type species, G. ulrichana. Miller has claimed (in his 2d appendix to *American geology and paleontology* 1897, p. 788) that the same form was described before by Meek as Proetus spurlocki[1]; and at the same time it has been suggested that these fossils may represent the young of Asaphus megistus, to which Proëtus spurlocki was referred by Miller in the first edition of his *American geology and paleontology*. It does not seem, with the evidence thus far gathered, opportune to unite these species and the subgenus Gerasaphes with the common Trenton Isotelus, for it must be assumed that Hall as well as Meek and Clarke described their species with the knowledge of the characteristics of the young of Isotelus. Hall and Meek figure specimens of Isotelus side by side with this new form; Meek, even a young Isotelus on the same plate with his Proëtus spurlocki, and Clarke compares his form with the immature stages of the race. On the other hand, it might be urged that all these forms described as new refer to very small specimens, and have been found at different horizons, Proëtus spurlocki in the lower part of the Cincinnati group, G. ulrichana in the Utica beds, thus giving a form which should represent only a final stage of development a rather long range, and also that all have been found associated with Isotelus gigas-maximus (=megistus); facts which would suggest the specific

---

1 Am. jour. sci. 1872. 3:426.

identity of these forms with Isotelus gigas. As long as the development and stages of Isotelus are not fully known, it seems eminently proper to denote the presence of these remains of immature character by the first specific name proposed for them, and by the subgeneric term which has been originated to include forms of the descending line of the Asaphidae, exactly corresponding with the generally recognized subgenera Ptychopyge and Niobe of Angelin in the ascending series of the Asaphidae. (Group 6)

ILLAENUS Dalman

Illaenus americanus Billings. Can. nat. and geol. 1859. 4:371

Cranidia and pygidia of this species are frequently found in the gray crystalline and the black compact limestone. They range in size from 1 mm in length to the normal size of adults. Most of them show the characteristic even convexity of the glabella of this species (an exception is made for several large cranidia from the pebbles with Tretaspis, in which the posterior half is nearly flat, and the anterior part consequently more abruptly bent downward) the sigmoidal curve of the dorsal furrows and the fine squamous striae. In the proportions of the cranidia there exist wider differences, as was supposed by Billings, and it almost seems as if there were two series of heads, one wide and short, such as Billings figured, and one relatively narrow and long, the younger heads specially showing frequently the latter proportions. It is quite probable that these differences are of a sexual nature. Young specimens have the dorsal furrow extending longer, in the smallest examples to fully the middle of the cranidium, whence a shallower depression extends in the direction of the last outward turn of the dorsal furrow to the frontal margin, a feature which is more emphasized in the subgenus Thaleops.

Another character more distinct in young stages is a median depression on the cast of the cranidium, with a central ridge, both extending from the occipital ring to the frontal border. The integument shows only a corresponding faint median depression.

In mature specimens this feature is not observable. It is, however, known in European forms and has been recognized by Pompecki in specimens of Illaenus comas (pl. 3, fig. 19) and I. linnarssoni?. The two lunate cicatrices in front of the sigmoidal curves mentioned by Dr Clarke[1] from casts from the Galena limestone at Wykoff, are distinctly noticeable on some of these casts. Illaenus americanus is restricted in Canada, New York, and western localities, to the Trenton and can therefore be considered a good index fossil of that formation. Dr White has however lately reported this species as occurring also in the Black river beds of the Rathbone creek section on the West Canada creek near Trenton Falls. (Groups 5, 7)

THALEOPS Conrad

Thaleops ovata Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:332

Two pygidia from the gray crystalline limestone agree with the descriptions of this part of the carapace of Thaleops ovata given by Conrad and later authors. Thaleops ovata has thus far been found in the Mississippi and Ohio basins, as well as in Canada, only in beds corresponding to the New York Lowville limestone. (Group 7)

CYPHASPIS Burmeister

Cyphaspis matutina *sp. nov.*

Pl. 4, fig. 5, 6, 7

Two small cranidia belonging to the genus Cyphaspis were found in the black limestone. The glabella is short, roundish subquadrangular, moderately and uniformly convex, sloping equally to all sides; surrounded by deep dorsal furrows and an equally deep frontal furrow. Three pairs of glabellar furrows are discernible, the first two faint, short and oblique, the third semicircular, extending to the occipital furrow, and separating a pair of less convex lobes, which extend a little beyond the lateral margin of the first and second lobes; the broad border slopes steeply to a narrow rim, somewhat upturned at the margin. The two specimens differ considerably in size, the one

[1] Geol. Minn. Pal. 1897. v. 3, pt. 2, p. 715.

being twice as large as the other, but they are otherwise too closely alike to allow a specific separation. The glabella and rim are apparently completely smooth, but show under the glass fine transverse striae. Neck ring nearly flat, depressed, with a central tubercle; occipital furrow distinct, nearly straight. Sutures begin at the anterolateral angles of the margin, extend in the direction of the second glabellar lobe to near the glabella, and then curve backward. Only a few species of this genus are known from the Lower Siluric of America, viz:

C. girardeauensis Shumard,[1] which, though approaching this species in the outline of the glabella, differs distinctly by the much narrower frontal limb of the fixed cheeks, which in C. matutina is almost as wide as the glabella, while in C. girardeauensis the interspace between the glabella and the rim is not broader than the latter.

C.? brevimarginata Walcott, from the Pogonip of the Eureka district of Nevada, has an entirely different glabella, which is conic in shape, and the frontal limb consists only of a narrow rim in front of the glabella, and

C.? galenensis Clarke, from the Galena shales at Cannon Falls Minn., which, though possessing a similarly formed glabella, lacks the basal glabellar lobes.

The lower Siluric of Europe is also very poor in species of Cyphaspis. According to Frech a representative not yet specifically determined is reported from the Chasmops limestone of Sweden. Barrande describes a similar species as C. sola, from the *étage* D, at Koenigshof, which comes nearest to the species from Rysedorph hill, specially in the width of the frontal limb and the direction of the anterior part of the suture line, but the glabella is not so nearly square in front, and the basal lobes are a little more separated from the glabella. It approaches in this feature more the C. girardeauensis. Pompecki describes and figures a similar form as Cyphaspis parvula[2] from glacial boulders of the province of East Prussia, probably derived from the Phaseolus kalk. (Group 5)

[1] Geol. Mo. 1855. p. 197, pl. 8, fig. 11.

[2] Trilobiten-fauna der Ost- und Westpreussischen Diluvialgeschiebe, pl. 6, fig. 28.

Cyphaspis hudsonica *sp. nov.*

Pl. 4, fig. 8, 9

In this connection may be mentioned a cranidium found in the upper Utica shale of Green Island (*see* state museum, Bul. 42, p. 526) which, though somewhat defective, deserves notice on account of the rarity of this genus in these lower terranes, and the fact that no representative of the same has as yet been observed in the Utica shale.

The glabella is broadly subovate, with a subangular frontal lobe, truncate behind, flanked by deep dorsal furrows, moderately convex (apparently somewhat compressed as indicated by a longitudinal median fold); the basal lobes are distinctly set off; the full extent of the basal glabellar furrow is, however, not known; no other glabellar furrows are observable. The frontal limb is only little depressed below the surface of the glabella in front of the latter, and slopes but slightly toward the frontal rim, more rapidly toward the facial sutures; the frontal rim is thick, almost vertically upturned, forming part of a curve; from the intersection with the frontal rim the facial sutures turn obliquely toward the basal lobe, running then parallel to the dorsal furrow, and leaving a small strip at the side of the glabella.

Though this is all that is known of this species, it is sufficient for the generic determination of the form, and the demonstration of the presence of the genus within the Utica beds. This form closely approaches most Shumard's C. g i r a r d e a u - e n s i s, and differs apparently only in the greater breadth of the frontal limb left between the facial sutures, which intersect the frontal rim farther back, and approach the glabella more rapidly in that western form. It is also similar to C. m a t u t i n a in all parts except the narrower frontal limb; the rim in the Trenton form is only little upturned and rather flat, but here thick and sharply upturned. More extensive material may necessitate uniting both the Trenton and Utica forms under one specific name. With our present knowledge it would seem

more practical to emphasize the difference, and to recognize the form by a separate term.

Horizon and locality. Upper Utica shale, Green Island, near Albany N. Y.

BRONTEUS Goldfuss

Bronteus lunatus Billings. Geol. sur. Can. rep't progress. 1853-56. p. 338

Pl. 4, fig. 10, 11

A single cranidium from the black limestone, which proves to belong to the only species of Bronteus yet found in the North American Lower Siluric, viz Bronteus lunatus Billings. The character of the species, which is said by Billings to be not infrequent in the Trenton limestone of Ottawa, but which hitherto has not been represented in the state of New York, was fully elucidated by Billings, and its relations to the subdivisions of Bronteus commented on by Dr Clarke, who reports it from the Trenton limestone near Springvalley and Wykoff, Minn. Lately the species has also been reported from the Trenton of the far northwest (Birch island, Kinwow bay, Lake Winnipeg) by J. E. Whiteaves.[1]

The species is said to possess all the characteristic features of a typical Bronteus, but, as pointed out by Clarke, it possesses only six pygidial ribs, while by far the greater number of species of Bronteus possess seven, and it agrees in this regard with the two species known from the corresponding lower Siluric beds of Europe, viz B. laticauda Wahlenberg and B. hibernicus Portlock.

B. lunatus Billings is thus far only known from the Trenton limestone and according to Billings restricted to it.

Horizon and locality. Black compact limestone pebble with Tretaspis, Ampyx, etc. from the Rysedorph hill conglomerate. (Group 5)

---

[1] Pal. foss. 1897. v. 3, pt 3, p. 235.

CYBELE Lovèn

Cybele *sp.*

Pl. 4, fig. 12

From a pebble of compact, black limestone the anterior part of a pygidium was obtained, which, though not furnishing enough data for the description of the species, is still interesting enough to elicit a few remarks.

The axis is long, conical; its annulations are, in the anterior parts, indicated only along the margin, in the middle part suppressed and the ornamentation furnished by two pairs of tubercles, while more posteriorly the annulations extend entirely across the axis. There are five pygidial pleurae which leave the axis under nearly right angles but gradually become deflected to a direction parallel with the axis. A few tubercles appear on these pleurae.

The character of the deflection of the pleurae leaves no doubt that this fragment belongs to the genus Cybele. Only one representative of this encrinurid genus has thus far become fully known from the North American Paleozoic rocks, viz. Cybele winchelli Clarke, from the Galena (?) limestone of Minnesota.[1] A pygidium has further been figured by Billings[2] as belonging to Encrinurus mirus, which indicates the presence of Cybele in that part of the Quebec group of Newfoundland that is homotaxial with the New York Black river or lower Trenton group. From Cybele winchelli our form differs markedly in not having the pleurae deflected abruptly and in the tuberculation and character of the annulations upon the axis. But it differs from the Newfoundland specimen apparently only in its slow tapering axis, and fuller material would probably prove the identity of the New York and Newfoundland forms.

In the Lower Siluric of Europe occur quite a number of species of Cybele, viz. 9 in Russia, 6 in Scandinavia, and 2 or 3 in England (according to Zittel). This relative frequency of Cybeles in Europe contrasted with their extreme rarity in the homotaxial American formations would already suggest the probable deriva-

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p. 742.

[2] Can. pal. foss. 1865. v. 1, p. 291, fig. 282.

tion of the eastern North American forms from European forms, a suggestion which is corroborated by the close relationship of the New York and Newfoundland forms with the common tuberculate Cybele verrucosa Dalm. of the Caradoc and Llandeilo of Great Britain. The specimen in the writer's hands differs in no essential features from the pygidia figured by McCoy[1] as Zethus atractopyge, sexcostatus and rugosus, which names are synonyms of Cybele verrucosa.

Horizon and locality. Gray limestone pebble of Rysedorph hill. (Group 7)

CALYMMENE Brongniart

Calymmene senaria Conrad. N. Y. geol. sur. 4th an. rep't Pal. 1841. p. 49

A large head, marked by its long shovel-shaped anterior expansion as belonging rather to this species than to C. callicephala Green[2] was found in the black limestone. This is the common Trenton form, while C. callicephala occurs in the Trenton as well as in the Lorraine beds. (Group 5)

CERAURUS Green

Ceraurus pleurexanthemus Green. Monograph tril. N. Am. 1832. p. 83

Cranidia and free cheeks are common in the pebbles of gray crystalline limestone and rare in those of compact black limestone. This form has a very considerable vertical range and wide geographic distribution; it ranges from the Lowville limestone to the Lorraine beds and has been found in Baffin Land (Schuchert) as well as in Manitoba (Whiteaves) and in the eastern and central parts of the United States. (Groups 5, 7)

SPHAEROCORYPHE Angelin

Sphaerocoryphe major *sp. nov.*

Cf. Sphaerocoryphe robustus Walcott. Cin. quar. jour. sci. 1875. 2:273

Pl. 4, fig. 13, 14

Two cranidia with spheric glabellar frontal lobes were found in the black limestone pebbles which are filled with specimens of

[1] Sedgwick and McCoy, Brit. Pal. foss 1855. pl. 1G, fig. 1-8.

[2] On the relation of these species see Geol. Minn. Pal. 1897 v. 3, pt 2, p.699,

Tretaspis. A comparison of this with typical specimens of S. robustus in the state museum, one of which is figured here, and with Walcott's careful description of this interesting species demonstrated the fact that there exists no tangible difference in the morphology of the cranidia, but that the Rysedorph hill specimens were four times as large as that species. As the cranidia of all the species of the genus are uniformly constructed, the failure to find differences between the two Trenton forms is of but little importance in the face of the great difference of size, and the latter must be regarded as forbidding an unqualified identification. Walcott obtained his species from the upper third of the Trenton limestone of Trenton falls. It has apparently not yet been found in any other locality, if two spheric anterior terminations mentioned by Whiteaves from the region of the Lake Winnipeg as Staurocephalus *sp. indet.* are not indicative of the occurrence of this or a congeneric species in the Trenton of the northwest; for, the glabellas of Staurocephalus and Sphaerocoryphe differ essentially only in the number of glabellar furrows behind the bulbous anterior lobe, Staurocephalus having three pairs and Sphaerocoryphe only two, and the bulbous frontal lobe alone does not permit an exact determination of the generic relation of a form.

The genus Staurocephalus is at present known in America only by the species S. murchisoni from the Niagaran of Arkansas and Illinois (*fide* Gilbert van Ingen). The genus Sphaerocoryphe is well represented in the lower Siluric of northern Europe, while in America only one other species has been made known by Billings from the Anticosti group.

DALMANITES (Emmerich) Barrande

Dalmanites achates Billings. Can. nat. 1860. 5:63

Specimens of Dalmanites achates represented by cranidia and pygidia were found in the gray crystalline limestone, the cranidia exhibiting the characteristic broad curve of the frontal margin, and the pygidia the narrow, elongate, tri-

angular outline with about 14 annulations on the axis, and about 10 ribs with pleural grooves. The species was originally described from the Trenton limestone of Ottawa. Dr Clarke figures a specimen from the Trenton limestone and reports it from the middle Trenton of Minnesota, and in a variety with extremely broad frontal lobe of the glabella from the Hudson river group at Cincinnati. As no mention of this form is made in other reports of Trenton faunas, it is either often overlooked by failing to be distinguished from Pterygometopus callicephalus or is of rare occurrence, as asserted by Billings. (Group 7)

PTERYGOMETOPUS Schmidt

Pterygometopus eboraceus Clarke. Geol. Minn. Pal. v. 3, pt 2, p. 728

Pl. 4, fig. 15

Two cranidia, obtained from a gray crystalline limestone boulder, were found to agree with the description and figures of the corresponding parts given by Dr Clarke of a new species, collected at Rawlins Mills in Saratoga county. The important features which demonstrate the identity of the forms from Rysedorph hill with that species, are the convexity of the median portion between the first and second lobes, the short incised character of the separating furrows at their inner extremities, and the confluence of the lobes along the dorsal furrows, as well as the presence of a conspicuous tubercle at the center of the occipital ring.

The occurrence of this form in the pebbles of the Rysedorph hill conglomerate seems to be of special interest, as the species has thus far been found only in the Trenton limestone at Rawlins Mills, hence in beds which outcrop only a relatively short distance to the north, and which may be contiguous with those from which these boulders were derived.

A new species more closely related to Pt. eboraceus than to any other species has lately been described from the Trenton of Silliman's Fossil Mount on Frobisher bay in Baffin Land. (Group 7)

Pterygometopus callicephalus Hall *sp.*

Phacops callicephalus Hall. Pal. N. Y. 1847. 1:247
Numerous cranidia and pygidia of this species were found in the gray crystalline and black compact limestone pebbles, and a few also in the reddish gray, hard limestone pebbles. P. callicephalus ranges from the Lowville limestone into the Trenton beds and occurs from Canada and New York to Minnesota and the Winnipeg region. (Groups 5, 6, 7)

LEPERDITIA Rouault

Leperditia fabulites Conrad *sp.*

Cytherina fabulites Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:332

Pl. 5, fig. 19, 20

A small number of this robust ostracode type were found in the gray crystalline limestone boulders of Rysedorph hill, some of them of considerable size, as shown by the natural size figure of the largest specimen (pl. 5, fig. 19). The writer does not believe that much can be added to the exhaustive description given by Ulrich,[1] who had a large amount of material at command. A peculiar feature is shown by the largest specimen figured, which, probably, has some relation to the two series of small papillae observed by Ulrich on the inner side of the anterior and posterior thirds of the right valve. The specimen from Rysedorph hill, which is also a right valve, shows on the outside, in a position corresponding to the internal papillae, six radiating furrows which, beginning at the internal margin of the small, short, flat border, into which they enter, become shallower and narrower toward the margin. The flat rectangular interspaces are each marked by a very distinct flabellate group of striae (fig. 20).

Leperditia fabulites is a characteristic and common fossil of the Lowville limestone in New York about Lake Huron and other parts of Canada, Kentucky, Illinois, Tennessee, Wis-

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p. 624 f.

consin and Minnesota; it has also been found in the Black river beds of the Poland limekiln section by White[1] and in the Moshier quarry, near Newport, by Prosser and Cumings;[2] and in the Trenton of Canada and New York, where the last named investigators found it[3] in the upper third of the limestone section at Trenton Falls, and in the limestone of Tribeshill, and Pattersonville in the Mohawk valley. (Group 7)

Leperditia resplendens *sp. nov.*

Pl. 5, fig. 21–27

Valves subrectangular, hinge line straight, cardinal angles drawn out into mucros, anterior and posterior ends subparallel, the anterior slightly truncate, ventral margin little curved, subparallel to the dorsal line, ventral angles uniformly rounded.

Surface forming an inclined plane, beginning near the ventral margin and sloping sometimes with a slight convexity or concavity to the hinge line, ventral slope abrupt, vertical, or even slightly overhanging. Surface when well preserved strongly glossy, in oblique light, however, exhibiting a very shallow pitting as of internal pores shining through the surface layer. Eye tubercles distinct in a shallow nuchal furrow. Muscle spot often externally indicated as a round shallow pit.

Most specimens show a very pretty, regular, pitting over the ventral part, separated by an irregularly jagged outline from the smooth glossy part, which lies higher than the pitted part of the shell. Other valves show only scattered fragments of the apparently smooth surface layer over the pitted part of the valve and there are other specimens where the entire surface is pitted. In those forms where the surface cuticle is somewhat less exfoliated, the position of the muscle spot is indicated by a more or less asteroidal fragment of the smooth layer preserved above the pitted parts.

A deep furrow passes from near the cardinal angles around the

---

1 Trans. N. Y. acad. sci. 1896. 15:83.

2 N. Y. state geol. 15th an. rep't. 1898. 1:631.

3 N. Y. state geol. 15th an. rep't. 1898. 1:625.

ventral margin, and a narrow inward beveled margin is observable in other specimens.

Dimensions. Length .9 mm, hight .6 mm, thickness .1 mm; other specimens .11 x .7 x .1 mm; .11 x .8 x .1 mm.

Horizon and locality. Extremely common in the more fine-grained parts of the gray crystalline and of the compact reddish gray limestone pebbles, where it, in spite of its very minute size, belongs to the striking fossils by the pretty gloss on its deep black valves. (Groups 6, 7)

ISOCHILINA Jones

Isochilina armata Walcott *var.* pygmaea *var. nov.*

L e p e r d i t i a (I s o c h i l i n a) a r m a t a Walcott. N. Y. state mus. 35th an. rep't 1884. p. 213, pl. 17, fig. 10

Pl. 7, fig. 19–25

About 20 specimens of this crustacean have been found in the pebbles of compact reddish gray and black limestone and agree in all essential features with that described by Walcott from the Lowville and Black river limestone of Russia, Herkimer co. N. Y. The greatest difference between this species and the variety from Rysedorph hill is found in the relative size, Walcott's type measuring 8.5 mm, while the specimens from Rysedorph hill only range between .85 mm and 2.15 mm, the average size of the majority of the apparently mature specimens being 2 mm.

Both forms have in common the elongate carapace, straight hinge line, mucronate anterior and posterior cardinal angles. The large type is farther described as having the anterior extremity broadly rounded; ventral curve uniform, posterior extremity obliquely rounded to the ventral curve, a relation between the margins which also appears in some of the specimens figured, while in the great majority, as also in Walcott's specimens, both anterior and posterior margins are nearly equally rounded.

The most characteristic feature of this species, and the one which gave it its name, is a strong unciform spine, described as

projecting "obliquely outward, the apex extending beyond the ventral margin and curving towards the anterior extremity of the valve; the section of the spine at the base is elliptical, becoming sharply angular on the posterior side as it nears the apex." The shape and relation of this spine seems to be subject to some variation, as in the largest specimen found and figured (pl. 7, fig. 20) it is short and clawlike, while some younger ones possess a remarkably long and straight spine (pl. 7, fig. 24). This is always situated in the posterior half and directed posteriorly, the anterior half being marked by its lesser convexity and the often very distinct eye tubercle. If the tubercle shown in the figure of Walcott's type specimen also represents the eye tubercle, the spine is directed backward in that form also. The surface of the specimens from Rysedorph hill is smooth and shining; the muscle spot has not been observed.

A feature not mentioned in the description of the type, but indicated in the drawing and of great prominence in the writer's material, is a depression, extending medially from the middle of the cardinal line to the ventral margin. In internal casts of this thick-shelled ostracod it appears as a very deep furrow slightly curved ventrally. A shorter impression corresponding to the nuchal furrow is sometimes observed on the anterior half; it does not, however, contain the eye tubercle, which lies farther forward.

On account of the absence of any observable overlap, the leperditoid form, the shallow median depression and the distinctness of the eye tubercle and muscle spot, this form is better retained under the genus Isochilina, and is probably not related to other genera with a similar median depression such as Leperditella and Primitiella.

Horizon and locality. Black and reddish gray compact limestones of the Rysedorph hill conglomerate. (Groups 5, 6)

APARCHITES Jones

Aparchites minutissimus Hall *var.* robustus *var. nov.*

Leperditia (Isochilina) minutissima Hall. Descrip. sp. foss. Hud. riv. gr. 1871. p. 7

Pl. 7, fig. 6–11

In the black compact limestone associated with Remopleurides linguatus several specimens of Aparchites were found, which not agreeing fully with the description of the species above cited are considered as representing a variety of it.

Diagnosis. Carapace elongate oval, rather large for this genus, cardinal margin slightly concave, cardinal angles rounded, anterior margin narrowly rounded, ventral margin obtuse posteriorly, posterior margin broadly and evenly rounded, posterodorsal part truncate. Valve quite strongly and very evenly convex, highest part near the center, or a little posteriorly and ventrally of the center. Ventral edge narrowly and slightly beveled. No sulcus, eye tubercles, or muscle impressions observable. Surface smooth.

Dimensions. Largest specimen (fig. 9): length, 2.4 mm; hight, 1.4 mm; thickness .7 mm.

Horizon and locality. Black compact limestone pebbles of the Rysedorph hill conglomerate. (Group 5)

Observations. Two specimens have been figured, which present considerable difference in relative hight and length, the larger, which is about normal, being relatively longer than the smaller and relatively higher specimen. This type does not present any marked differences from Aparchites minutissimus, specially from the Trenton variety of this species, described by Ulrich, except in the great difference in size, this form being more than twice as large as the other.

SCHMIDTELLA Ulrich

Schmidtella crassimarginata Ulrich *var.* **ventrilabiata** *var. nov.*

Schmidtella crassimarginata Ulrich. Am. geol. 1892. 10:269

Pl. 7, fig. 12–18

Under this varietal designation a form is characterized, which is extremely common in the reddish gray, compact, ostracode limestone of Rysedorph hill.

Diagnosis. Carapace broadly suboval, almost equilateral; hinge line nearly straight, shorter than the length of the valve; cardinal angles obtuse, anterior and posterior margins strongly rounded, the posterior a little more than the anterior one; ventral outline of body of valve uniformly curved. Body of valve very strongly convex, highest dorsally of the center, back of valve projecting above the hinge line, causing the dorsal outline to appear more or less arcuate, and producing an incurving triangular cardinal area. A depressed convex to flat border begins at the cardinal angles and encircles the valve, rapidly widening in the ventral region, and mostly assuming the form of a tongue-shaped or lip-shaped lappet. Surface smooth and shining.

Dimensions. Length of body of valve of one specimen .7 mm, hight of same .45 mm; thickness .3 mm; width of ventral border .2 mm; length and hight of body of valve of another .9 mm and .6 mm and width of border .2 mm.

Horizon and locality. Reddish gray compact, ostracode limestone pebbles of the Rysedorph hill conglomerate. (Group 6)

Observations. This form agrees in all principal features with Schmidtella crassimarginata Ulrich, from the Stones river (Lowville limestone) of Mineralpoint Wis., and Dixon Ill. It differs only in the stronger development, specially in the ventral region, of the marginal border, a difference which cannot be considered to indicate more than a regional variety within the confines of the species.

EURYCHILINA Ulrich

Eurychilina reticulata Ulrich. Contrib. Can. micro-pal. 1889. pt 2, p. 52

Pl. 5, fig. 3

In the reddish gray limestone several specimens of a very pretty ostracode were found, which, by their reticulate surface, shape and extent of the sulcus and the structure of the marginal area, prove their identity with Ulrich's Eurychilina reticulata. In view of the equality of their important characters, no value can be attributed to certain small differences, as the smaller size of the pits. Eurychilina reticulata has been found heretofore only in the Lowville and Black river limestones of the west. (Group 6)

Eurychilina bulbifera *sp. nov.*

Pl. 5, fig. 14–17

Diagnosis. Carapace nearly semicircular, rather high, with straight cardinal margin, strongly rounded anterior and posterior margins, and less curved ventral margin. Sulcus about one third of the length of the valve from the posterior end, deep, extending one half the width of the convex part of the carapace. Posterior part distinctly bulbous, higher than the rest of the shell. Anterior and middle part strongly convex, highest ventrally of center. Broad marginal area, with widely separate but very high radial folds, exteriorly concave, abruptly upturned at the margin, where a vertical outer closing wall is observable. Surface finely granulose, with the exception of the marginal area, but the vertical closing wall is distinctly granulose.

Dimensions. Length of larger specimen 1.4 mm, hight .9 mm, thickness .4 mm.

Horizon and locality. In the compact reddish gray and gray crystalline limestone pebbles of the Rysedorph hill conglomerate. (Groups 6 and 7)

Observations. This form may be easily distinguished from other members of the genus by its short, convex form, large, strongly

bulbous posterior part, strong sulcus and granulose surface. Its posterior bulb suggests species of Ctenobolbina, but as also other Eurychilinas have a small node just posteriorly of the sulcus, it is evident that this bulb only represents an extravagant development of such node. The degree of its convexity and its granulose surface are features in which it is comparable to E. granosa, and E. subaequalis Ulrich, but these latter do not possess the upturned marginal border, nor the strong development of the posterior node.

Eurychilina (?) solida *sp. nov.*

Pl. 5, fig. 18

A single specimen of a granulose Eurychilina found in the compact ostracode limestone of Rysedorph hill, agrees in most characters with the preceding species but differs in others. These are the perfect separation of the sulcus from the cardinal line, the sulcus forming here a small deep crescent-shaped pit near the middle of the valve; the remainder of the carapace, except the marginal area, is strongly and very uniformly convex; and the marginal area more strongly concave, and rising much higher than in E. bulbifera. A break just behind the sulcus seems to indicate the presence of a node. The exterior and interior closing walls of the marginal area have not been observed, and it is, therefore, not certain whether this form is really a Eurychilina, or possesses only a simple border or "frill."

Dimensions. Length 1.2 mm; hight .9 mm; thickness .3 mm.

Horizon and locality. Compact gray limestone pebbles of the Rysedorph hill conglomerate. (Group 6)

Eurychilina subradiata Ulrich *var.* rensselaerica *var. nov.*

Eurychilina subradiata Ulrich. Geol. Minn. Pal. 1897. v. 3, pt 2, p. 663

Pl. 5, fig. 4–7, 13

Diagnosis. Carapace rather large, elongate, semi-elliptic to subtrapezoidal, cardinal line longer than any other part of the shell, straight, cardinal angles short; anterior and posterior

margins nearly equally converging toward the ventral margin, which is subparallel to the cardinal line. Depressed convex, the highest part consisting of an obtuse ridgelike prominence, running across the shell longitudinally and ventrally of the center; from the ridge the valve slopes evenly or with slight concavity toward the thickened cardinal edge. Sulcus rather broad, situated mostly somewhat posteriorly of the median line, and beginning a little ventrally of the cardinal line. No distinct node or bulb situated behind the sulcus. Marginal area consisting of a high angular ridge, which encircles the entire lateral and ventral margins of the valve, and which varies somewhat in breadth, but always becomes narrower along the ventral margin, where it abruptly turns downward. Outside of this lies still a narrow, flat, radially striated border, which, however, is mostly broken off. Surface in some specimens very coarsely pitted, in others very faintly so, in most, however, perfectly smooth. Shell very thin, specially the marginal area.

Dimensions. Length 2.1 mm; hight 1 mm; thickness .4 mm.

Horizon and locality. Common in the gray crystalline and compact limestone pebbles of the Rysedorph hill conglomerate. (Groups 6, 7)

Observations. This form has all the essential features of Eurychilina subradiata Ulrich; it differs only in the absence of the distinct node and the more acute cardinal angles, differences which are of not more than varietal importance, such as the same species is very likely to develop in widely separated regions. Eurychilina subradiata has thus far been found in Illinois, Tennessee, Wisconsin, and Minnesota, where it is restricted to the Lowville limestone.

Eurychilina dianthus *sp. nov.*

Pl. 5, fig. 1, 2, 8, 9

Diagnosis. Valve very thick, suboval, equilateral; cardinal line straight, cardinal angles obtusely rounded, anterior and posterior margins nearly equally and strongly rounded;

ventral margin more gently rounded. Body of valve moderately to strongly convex, highest in the central region, from which it slopes equally to all sides. The largest of the figured specimens, which is slightly exfoliated, shows an apical muscle impression; another an elongate prominence, situated nearer to the cardinal line, evidently the filling of a muscle impression; while a third specimen (pl. 5, fig. 2) which has the crust preserved, shows an elongate kidney-shaped apical impression, which is evidently the last trace of the sulcus. Marginal area not concave and curved outward as in the other species, but more or less convex and curving inward, becoming wider toward the ventral region, and provided with strong radiating ribs, which in some specimens are partly composed of granules. Surface very faintly granulose.

Dimensions. Length 2.1 mm; hight 1.6 mm; thickness .6 mm.

Horizon and locality. Gray crystalline limestone pebbles of Rysedorph hill conglomerate. (Group 7)

Observations. This interesting form can be compared only with Eurychilina aequalis, from the Chazy and Lowville limestone (Stones river group) of Kentucky,[1] from which it seems to differ only in not possessing a distinct sulcus, and in having the marginal area strongly ribbed.

Eurychilina obliqua *sp. nov.*

Pl. 5, fig. 10–12

There have been found in the gray limestone several large specimens of Eurychilina which are nearly related to E. dianthus, but differ uniformly in certain important features. These are the more elongate form of the semi-elliptic valve, the greater convexity of the body of the valve, and the situation of the apex of the convexity in the posterior half, whence the valve evenly slopes anteriorly, the entire absence of any trace of an apical sulcate impression, and the considerably greater width of the marginal convex area, which soon reaches its full

[1] Cin. soc. nat. hist. Jour. 1890–91. 13:129.

width in front, while posteriorly it narrows considerably. The ribs of the marginal area are finer than in the preceding species. On account of the posterior convexity of the body of the valve and the inequilateral development of the marginal area, the entire valve has a strongly symmetric appearance.

Dimensions. Length 2.4 mm; hight 1.7 mm; thickness .9 mm.

Horizon and locality. Gray limestone of Rysedorph hill. (Group 7)

There is no species known to the writer which is suggested by this form. If the development of the sulcus is taken into consideration, it seems to stand at the end of a series which begins with such forms as E. bulbifera, where the sulcus is deep and long and begins at the cardinal line. It then begins to wander ventrally, till it appears as a crescent-shaped pit only, separate from the cardinal line as in E. granosa and in E. solida; it farther becomes faint, and may eventually disappear entirely as in E. obliqua. At the same time the forms with faintly developed sulcus have more rotund valves, and mostly a convex instead of a concave marginal area; they form, hence, apparently a natural group of species, which eventually may be advantageously comprised under a subgeneric term.

PRIMITIA Jones & Holl

Primitia mundula Miller *var.* jonesi *var. nov.*

Primitia mundula S. A. Miller. Cin. quar. jour. sci. 2:350, and Ulrich, Cin. soc. nat. hist. Jour. 1890-91. 13:132

Pl. 7, fig. 2–5

The conglomerate affords very minute representatives of the genus Primitia, which have been found to belong all to one type that probably stands in varietal relation to Primitia mundula S. A. Miller.

Diagnosis. Carapace very minute, strongly convex, subquadrate-ovate, dorsal margin long, straight; anterior cardinal angle obtusely rounded, posterior a little less obtuse; anterior mar-

gin strongly rounded, ventral margin more gently curved, posterior margin less curved, truncated above; sulcus in about the middle of the valve, deep ventrally, not reaching to the middle of the valve, curving slightly backward in the lower part; dorsal parts on both sides of the sulcus somewhat bulbous, the anterior part more distinctly so. Well preserved specimens show a flat border sloping steeply outward. Internal casts (fig. 5) possess a prominent tubercle at the inner end of the sulcus, evidently indicative of a deep muscle impression. Surface very finely granulose, the granules arranged in longitudinal rows, so that with a weaker glass the surface appears to be marked by longitudinal, anastomosing striae.

Dimensions. Length .7 mm; hight .5 mm; thickness .2 mm.

Horizon and locality. In the pebbles of gray crystalline limestone and of black compact limestone, Rysedorph hill. (Groups 5, 7)

Observations. These minute fossils show considerable similarity to P. m u n d u l a S. A. Miller, from the upper half of the Cincinnati group. They differ in being a little larger, in having the tumid dorsal parts more strongly developed, and specially in having a finely granulose surface. In consideration of the variability of P. m u n d u l a, shown by Jones and Ulrich, it is very probable that this form is only an earlier variety of the Cincinnati type. Jones's P. l o g a n i, from the Canadian Chazy (?) and Trenton, has the front moiety mostly narrower than the hinder part and is smooth and punctate, while his P. m u n d u l a var. e f f o s s a from the dark and fine grained limestone from the south of Montcalm market, Quebec city, is a form quite similar to ours, but differing still in being longer, having the sulcus developed in the center into a large pit and in being smooth. It occurs in beds which Lapworth and Ami have shown to contain the fauna of the Normanskill beds, in which the Rysedorph hill conglomerate is embedded, so that both these varieties of P. m u n d u l a are of older Trenton age.

BOLLIA Jones & Holl

Bollia cornucopiae *sp. nov.*

Pl. 6, fig. 1, 2

A single, odd-looking valve was found in the gray crystalline limestone pebbles from Rysedorph hill, which is referable to the genus Bollia Jones and Holl in a general way, but not to any of the species described as yet as constituting that genus.

Diagnosis. Valve subrectangular, cardinal line as long as the greatest length of the specimen, straight, cardinal angles nearly rectangular, anterior and posterior margins subparallel in the dorsal parts, curving inward ventrally, ventral margin subparallel to the cardinal line, shorter than the latter by one third. Body of valve flat, bearing a wide, u-shaped (horseshoe-shaped ridge of authors) which anteriorly widens into a broad, evenly depressed convex plate with an upturned border along the cardinal line; in the center of the valve it narrows abruptly into a semitubular ridge, which, slightly narrowing, completes the u-curve, curving inward at the cardinal line and ending with a small knob. Separated by a narrow furrow from this ridge and parallel with the lateral and ventral margins, runs the high marginal, obtusely angular ridge, which is highest along the lateral margins, and sinks rather abruptly at the antero and posteroventral angles almost to the level of the body of the valve. Its outer wall slopes very steeply. All parts of the apparently very thick-shelled valve are smooth.

Dimensions. Length 1.4 mm; hight 1.2 mm; thickness .7 mm.

Horizon and locality. One specimen found in a gray crystalline limestone pebble. (Group 7)

Observations. This valve has in general outline and the character of the marginal ridge some resemblance to the more common form referred to E u r y c h i l i n a s u b a e q u a l i s in this paper. The central part, the flat body and u-shaped central ridge, however, are entirely different from the evenly convex body of that **Eurychilina.**

The flat body of the valve, the u-shaped ridge and the marginal ridge are all characteristic features of the genus Bollia, but, while one or both ends of the loop-shaped ridge may be bulbous in that genus, no species known to the writer presents such a great difference in the development of the two ends of this ridge, nor is the marginal ridge usually situated so closely to the margin as it is in this species.

MACRONOTELLA Ulrich

Macronotella ulrichi *sp. nov.*

Pl. 6, fig. 6–16

In the gray crystalline limestone pebbles of the conglomerate at Rysedorph hill and the Moordener kill (pl. 7, fig. 1) occur representatives of the genus Macronotella known only by one species from the Lowville limestone of the west. This genus is characterized by Ulrich as follows: "Carapace convex, semicircular or semiovate, with a long nearly straight hinge; valves equal, full centro-dorsally, without ridges or a sulcus, but exhibiting a smooth subcentral spot where the ornament is omitted; surface, in the only species known, coarsely punctate." The affinities of the genus are thought to be with Kirkbya. In the conglomerate beds two species have been found, which are distinctly allied to Macronotella scofieldi, the type of the genus.

Diagnosis. Valves three fourths circular to subovate; dorsal outline rarely straight, mostly prominent in the central part, specially in older specimens; cardinal angles obtusely rounded to shortly truncate; posterior margin with a little longer truncation, lateral and ventral margins forming approximately a continuous circular line, in larger specimens the anterior and posterior margins more strongly rounded, and the ventral margin less curved; free edges in most specimens with a broad depressed border and beveled edge. Surface strongly convex, culminating in the dorsocentral region; in some specimens almost smooth, with only faint, widely and irregularly distributed circular impressions; others

with very large deep pits; on the apex always a flat, smooth circular area. Valve projecting slightly above the straight cardinal line, and forming a broad, low, triangular, reentrant cardinal area.

Dimensions. Length 2.7 mm; hight 2.1 mm; thickness .7 mm.

Horizon and locality. In the gray crystalline pebbles of the conglomerate on Rysedorph hill and at the Moordener kill. (Group 7)

Observations. This pretty species agrees with the type of the genus Macronotella in its convex valves, culmination in the dorso-central region, apical smooth spot, border and coarse punctation; it differs in being relatively much shorter and having a shorter cardinal line; it also has obscure or truncate cardinal angles. It appears that the definition of the genus should be so modified for the reception of this and the next species, as to embrace forms of not only long but also of relatively short hinge line.

This form shows a slight similarity to a round, punctate species with beveled border and dorso-central apex, from Scandinavian upper Siluric beds, described by Jones as Aparchites decoratus.[1] The Swedish form does not apparently possess the apical smooth spot and has a very short cardinal line; its reception into the genus Macronotella would therefore be not advisable.

Another species which may be mentioned in this connection, is Isochilina amii Jones,[2] from the Trenton limestone of Loretto, province of Quebec. This species is described by Prof. Jones as follows: "A small black valve, ovate oblong; dorsal border long and straight; anterior end evenly and posterior one elliptically rounded, ventral edge nearly curved and obscurely crenulated. Surface marked with small scattered pits; greatest convexity at the hinder moiety." It is added: "This seems to differ from all known forms. It has the Leperditian shape of Isochilina, although no sulcus nor tubercle is visible." There

[1] An. and mag. nat. hist. 1889. p. 273.

[2] Contrib. Can. micro.-pal. 1891. pt 3, p. 68, pl. 10, fig. 14.

exists a great similarity between the habitus of this and M. ulrichi, which finds its expression in the slightly convex dorsal line, well rounded anterior and posterior sides, scattered pits on the surface border, and the obscurely crenulated margin, which is also indicated in some of the species from Rysedorph hill by a faint radiation and radial arrangement of shallow impressions on the border. On the other hand, the Quebec form is relatively longer, has its greatest convexity posteriorly instead of centrally, and lacks the central smooth space. Prof. Jones had apparently only a single valve for description, and the possibility is therefore not excluded, that more extensive material would have presented features more closely agreeing with M. ulrichi.

Macronotella fragaria *sp. nov.*

Pl. 6, fig. 3–5

Another valve of Macronotella was found in the same limestone, possessing different characters from the foregoing.

Diagnosis. Carapace elongate, semiovate; cardinal margin nearly straight, anterior and posterior cardinal angles very obtusely rounded; anterior and posterior margins boldly rounded, ventral margin less curved. Surface strongly convex, culminating a little ventrally and posteriorly (?) of the center, very coarsely punctate; in the center is a circular, slightly projecting, smooth, flat plate, from which a tapering ridge extends to near the cardinal line. No border observable.

Dimensions. Length, 1.7 mm; hight, 1.5 mm; thickness, .6 mm.

Horizon and locality. In the gray crystalline limestone pebbles of the Rysedorph hill conglomerate. (Group 7)

Observations. This form differs markedly from both the other species by its strongly rounded cardinal angles, the culmination of the valve ventrally and posteriorly from the center, the absence of the border and the presence of the tapering ridge. The absence of the dorso-central inflation and of the border removes this form so much from the typical expression of the genus that the propriety of referring thereto may be ques-

tioned. On the other hand, the general outline, coarse pitting, and the central smooth spot are indications of its undoubted close relationship to Macronotella. A very similar form has been described by Dr Gürich[1] as Primitia ornatissima, from the lowest middle Devonic of Dabrowa. This later species possesses also a regularly pitted surface, a subcentral smooth spot and a smooth furrow, extending from the central spot dorsally; it is not so regularly oval, has its longest diameter nearer to the cardinal line and is more lenticular in profile than M. fragaria. Dr Gürich compares his species with Primitia ornata Jones, from the Wenlock beds[2] a form which also bears comparison with ours, but differs in having angular cardinal angles and a coarsely reticulated surface.

As the smooth median ridge of Macronotella fragaria rests also on a smooth, very faint impression, the relationship also of this species to Primitia is quite apparent. It seems that M. fragaria occupies an intermediate position between those genera, differing in some features from the typical expression of both of them.

BYTHOCYPRIS Brady

Bythocypris cylindrica Hall sp.

Leperditia (Isochilina) cylindrica Hall. N. Y. state cab. nat. hist. 24th an. rep't. 1872. p. 231

Pl. 7, fig. 26–28

Bythocypris cylindrica is a form of extremely frequent occurrence in the reddish gray compact limestone, of common occurrence in the gray, more crystalline limestone, and rarely found in the black compact limestone pebbles. It was described by Hall as occurring in the Hudson river group at Cincinnati, and is reported by Ulrich from the Trenton and Utica beds of the Cincinnati region and from the Lower Trenton (Clitambonites bed) of Cannon Falls Minn. The New York form

[1] Das Palaeozoicum im polnischen Mittelgebirge. Verh. der kaiserl. Russisch. mineral. Gesellsch. zu St Petersburg. 1896. 2d ser. 32:383.

[2] An. and mag. nat. hist. 5th ser. 1886. 17:411.

does not show any difference from the Cincinnati type, nor any approach to the other, partly larger Trenton species, described by Ulrich. One specimen has been figured to show the remarkable tumidity of the central ventral third, which may be caused by a state of pregnancy, such as is frequently indicated in valves of Beyrichias. (Groups 5, 6, 7)

LEPIDOCOLEUS Faber

Lepidocoleus jamesi Hall & Whitfield *sp.*

Plumulites jamesi Hall & Whitfield. Ohio geol. sur. Pal. 1875. v. 2, pt 2, p. 106

Pl. 4, fig. 16–19

The black limestone of the Rysedorph hill conglomerate furnished two plates with crustacean structure, which, on comparison, proved identical with a specimen collected in the Rafinesquina deltoidea bed of the upper Trenton limestone of Trenton Falls. The latter has been figured by the writer in another paper, for comparison with the figures of specimens of Lepidocoleus jamesi, found to occur profusely in the lower Utica beds of Mechanicsville, and occasionally in the upper Utica beds on Green Island. Hall and Whitfield remark that they detected fragments apparently identical with their Plumulites jamesi on surfaces of Trenton limestone from Trenton Falls, and the writer in a former paper concurred with this identification, and is as yet not prepared to separate the Trenton and the later forms, though it seems that the Trenton specimens have more closely arranged transverse striations. A critical comparison of the Trenton and Utica material is however greatly hindered by the very different preservation of the plates in the shale, where they are nearly completely flattened and reduced to a mere film, and in the limestone, where they retain all details of profile and surface sculpture. The latter fact makes the specimens from Rysedorph hill specially worthy of notice. This surface sculpture consists of a very delicate but distinct cross striation of the interspaces between the coarser transverse striations, consisting of two systems of

fine striae, intersecting at nearly right angles. The cross striations appear in one specimen on the transverse striations as minute nodes. The presence of this extremely pretty and regular surface ornamentation is not a feature distinguishing it from the Utica form, as the latter, on reinvestigation also shows traces of it.

The species was originally founded on such isolated plates as occur in the beds around Albany. Later, an entire specimen was found, and, as it proved to consist only of two rows of plates, a new genus Lepidocoleus was founded for it.[1] Two more species of the same genus, one from the Rochester shales, and one from the Helderbergian beds were subsequently described by Dr Clarke[2], the characters of the genus still more fully elucidated and, specially, the highly simple, unmodified form of this group of barnacles pointed out. In recognition of the important differences between Lepidoleus and the Turrilepadidae, Clarke has placed the genus in a distinct family, the Lepidocoleidae.

Associated with the broadly triangular plates with sigmoidal base which compose by far the majority of all plates observed, occur also more narrowly leaf-shaped plates with somewhat drawn out apex and simply rounded base. Medially they are marked by a narrow carina, extending from the apex to about the middle of the base. As they are associated with the others, possessing the same size and surface sculpture, they are evidently parts of the same exoskeleton. One of these plates from the Trenton shales at Port Schuyler near Albany has been figured by the writer in museum bulletin 42 on the Hudson river shales of the vicinity of Albany (pl. 2, fig. 11). Faber's specimen shows only two rows of equal plates, which are none of them carinate, and the distal, caudal extremity of the specimen is missing. This part is retained in the specimen described by Clarke from the Rochester shale; the terminal plate of the latter is described as being grooved on its narrow back. It is, therefore,

[1] Cin. soc. nat. hist. Jour. 1886. 9:16.

[2] Am. geologist. 1896. 17:137.

probable, that the long, leaf-shaped plate figured by the writer represents this plate of the exoskeleton of Lepidocoleus jamesi, and that the apparent carina is the reverse side of that groove. Several specimens of this type of plate structure have been observed by the writer.

Dr Woodward has described[1] a species of Turrilepas, obtained by Dr Ami in the lower Utica beds of Ottawa, as Turrilepas canadensis. This species is quite certainly not identical with the one represented by the Trenton and Utica specimens of the vicinity of Albany, referred to Lepidocoleus jamesi, for its plates are about three times as large as those of the latter, and differ materially in shape; the carina also lies not medially but close to the longer side. (Group 5)

ANALYSIS OF THE FAUNA OF THE CONGLOMERATE

Fossils contained in the various kinds of pebbles

c=common; cc=very common; r=rare; rr=very rare

GROUP		
1 Gray limestone		
	Hyolithellus micans *Billings*	
2 Gray and reddish sandstone		
	None	
3 Black crystalline limestone (Chazy limestone)		
	Bolboporites americanus *Billings*	
	Palaeocystites tenuiradiatus *Hall* sp.	
4 Lowville limestone		
	Tetradium cellulosum *Hall* sp.	
5 Black compact limestone		
	Streptelasma corniculum *Hall*	c
	Diplograptus foliaceus *Murch.* sp.	r
	Climacograptus scharenbergi *Lapworth*	r
	Stomatopora inflata *Hall* sp.	c
	Stictopora *cf.* elegantula *Hall*	r
	Callopora multitabulata *Ulrich*	cc
	Siphonotreta minnesotensis *Hall & Clarke*	rr
	Crania trentonensis *Hall*	r
	Rafinesquina alternata *Emmons* sp.	c
	Leptaena rhomboidalis *Wilckens*	c
	Plectambonites sériceus *Sowerby* sp.	c
	P. pisum *sp. nov.*	cc

[1] Geol. mag. 3d ser. 1889. 26:274.

5 Black compact limestone (*continued*)

Christiania trentonensis *sp. nov.*	c
Orthis tricenaria *Hall*	c
Platystrophia biforata *Schlotheim* sp.	c
Dalmanella testudinaria *Dalman* sp.	c
Whitella ventricosa *Hall* sp.	rr
Ctenodonta *sp. indet.*	rr
C. *cf.* astartaeformis *Salter*	r
Protowarthia cancellata *Hall* sp.	r
Conradella compressa *Conrad* sp.	r
Carinaropsis carinata *Hall*	r
Lophospira bicincta *Hall* sp.	r
Liospira americana *Billings* sp.	rr
Eccyliopterus spiralis *sp. nov.*	rr
Holopea paludiniformis *Hall*	rr
Conularia *cf.* trentonensis *Hall*	rr
Zitteloceras hallianum *d'Orbigny* sp.	rr
Tretaspis reticulata *sp. nov.*	cc
T. diademata *sp. nov.*	rr
Ampyx (Lonchodomas) hastatus *sp. nov.*	cc
Remopleurides linguatus *sp. nov.*	cc
Isotelus maximus *Locke*	c
Illaenus americanus *Billings*	c
Cyphaspis matutina *sp. nov.*	r
Bronteus lunatus *Billings*	rr
Calymmene senaria *Conrad*	rr
Pterygometopus callicephalus *Hall* sp.	c
Ceraurus pleurexanthemus *Green* sp.	c
Cybele *sp.*	rr
Sphaerocoryphe major *sp. nov.*	r
Isochilina armata *Walcott, var.* pygmaea *var. nov.*	r
Primitia mundula *Miller, var.* jonesi *var. nov.*	r
Aparchites minutissimus *Hall sp., var.* robustus *var. nov.*	c
Bythocypris cylindrica *Hall* sp.	r

6 Reddish gray compact limestone

Rafinesquina alternata *Conrad* sp.	r
Dalmanella testudinaria *Dalman* sp.	r
Triplecia nucleus *Hall*	r
Protozyga exigua *Hall*	c
Carinaropsis carinata *Hall*	r
Gerasaphes ulrichana *Clarke* sp.	rr
Ampyx hastatus *sp. nov.*	r
Remopleurides linguatus *sp. nov.*	r
R. tumidulus *sp. nov.*	rr
Pterygometopus callicephalus *Green* sp.	r
Leperditia resplendens *sp. nov.*	c

6 Reddish gray compact limestone (*continued*)	
Isochilina armata *Walcott, var.* pygmaea *var. nov.*	r
Schmidtella crassimarginata *Ulrich, var.* ventrilabiata *var. nov.*	cc
Eurychilina reticulata *Ulrich*	c
E. bulbifera *sp. nov.*	r
E. (?) solida *sp. nov.*	rr
E. subradiata *Ulrich, var.* rensselaerica *var. nov.*	c
Bythocypris cylindrica *Hall* sp.	cc
7 Gray crystalline limestone	
Prasopora simulatrix *Ulrich, var.* orientalis *Ulrich*	r
Rafinesquina alternata *Conrad* sp.	cc
R. deltoidea *Conrad* sp.	r
Leptaena rhomboidalis *Wilckens*	r
Plectambonites sericeus *Sowerby sp., var.* asper *James*	cc
P. pisum *sp. nov.*	r
Triplecia nucleus *Hall*	c
Orthis tricenaria *Conrad*	c
Plectorthis plicatella *Hall*	c
Dalmanella testudinaria *Dalman* sp.	c
D. subaequata *Conrad, var.* pervetus *Conrad*	c
Dinorthis pectinella *Emmons* sp.	r
Parastrophia hemiplicata *Hall*	r
Protozyga exigua *Hall*	c
Zygospira recurvirostris *Hall*	c
Modiolopsis *cf.* aviculoides *Hall*	r
Conradella compressa *Conrad*	r
Carinaropsis carinata *Hall*	c
Lophospira bicincta *Hall* sp.	c
L. perangulata *Hall* sp.	c
Liospira subtilistriata *Hall* sp.	cc
Clathrospira subconica *Hall*	c
Trochonema umbilicatum *Hall* sp.	c
Cyrtospira attenuata *sp. nov.*	rr
Hyolithus rhine *sp. nov.*	rr
Cyrtoceras subannulatum *Hall*	rr
Spyroceras bilineatum *Hall* sp. ? (teste *Emmons*)	
S. *cf.* anellus *Conrad* sp.	r
Remopleurides linguatus *sp. nov.*	rr
Isotelus maximus *Locke*	cc
Illaenus americanus *Billings*	c
Thaleops ovata *Conrad*	r
Pterygometopus eboraceus *Clarke*	r
P. callicephalus *Hall* sp.	c
Dalmanites achates *Billings*	c
Ceraurus pleurexanthemus *Green*	c

7 Gray crystalline limestone (*continued*)

Leperditia fabulites *Conrad*	c
L. resplendens *sp. nov.*	cc
Eurychilina bulbifera *sp. nov.*	r
E. obliqua *sp. nov.*	rr
E. subradiata *Ulrich, var.* rensselaerica *var. nov.*	c
E. dianthus *sp. nov.*	c
Primitia mundula *Miller, var.* jonesi *var. nov.*	r
Bollia cornucopiae *sp. nov.*	rr
Macronotella ulrichi *sp. nov.*	c
M. fragaria *sp. nov.*	rr
Bythocypris cylindrica *Hall* sp.	c

Tabulation of the faunas

The following tabulation of the organisms of the last three groups of pebbles is given to show the relative frequency of occurrence, and their vertical range in other regions.

Frequency and vertical range of species

B=Black river group; Ch=Chazy; D=Dicellograptus zone (Normans kill shale, Lower Dicellograptus zone); L=Lorraine beds; Lo=Lowville limestone (Birdseye limestone, Stones river group); R=Richmond beds; T=Trenton limestone; U=Utica beds.

	Gray limestone	Reddish gray limestone	Black limestone	N. Y.	Canada	West	Other regions
Streptelasma corniculum *Hall*	......	....	c	T	T	T	T of Baffin Land
Diplograptus foliaceus *Murchison* sp.	......	....	r	T·L	T·U	T·L	
Climacograptus scharenbergi *Lapworth*	......	....	r	D	D	....	
Stomatopora inflata *Hall* sp.	......	....	c	T	T	B·T	
Stictopora *cf.* elegantula *Hall*	......	....	r	T	....	....	
Callopora multitabulata *Ulrich*	......	....	cc	....	....	B·T	
Prasopora simulatrix *var.* orientalis *Ulrich*	r	....	......	T	T	B·T	
Siphonotreta minnesotensis *Hall & Clarke*	......	....	rr	....	....	Lo	
Crania *cf.* trentonensis *Hall*	......	....	r	T	....	T	
Pholidops trentonensis *Hall*	......	....	r	T	....	T	
Rafinesquina alternata *Emmons* sp.	cc	r	c	T·L	Ch·L	B·R	T of Manitoba Lake Winnipeg Europe ?
R. deltoidea *Conrad* sp	r	....	......	T	T	T	
Leptaena rhomboidalis *Wilckens*	r	....	c	T·Carb	T	T·Carb	Europe
Plectambonites sericeus *Sowerby* sp.	......	....	c	T·L T·U	Lo·L ?	Lo·R U	Europe
P. sericeus *var.* asper *James*	cc	....	......				
P. pisum *sp. nov.*	r	....	cc	....	....	....	
Christiania trentonensis *sp. nov*	......	....	c	....	....	....	
Triplecia nucleus *Hall*	c	r	......	T	....	....	
Orthis tricenaria *Conrad*	c	....	c	T	Lo·T	Lo·T	Baffin Land Lake Winnipeg
Plectorthis plicatella *Hall*	c	....	......	T	Lo·T	T·L	
Platystrophia biforata *Schlotheim* sp.	......	....	c	T·L	Chazy — Upp. Sil.	T·R	Baffin Land Europe
Dalmanella testudinaria *Dalman* sp.	c	r	c	Lo·L	Lo·L	Lo·R	Baffin Land Europe

Frequency and vertical range of species (*continued*)

	Gray lime-stone	Reddish gray lime-stone	Black lime-stone	N. Y.	Canada	West	Other regions
D. subaequata *var.* pervetus *Conrad*	c	......	......	T ?	Lo-B	Lo-B	
Dinorthis pectinella *Emmons* sp	r	......	......	T	Lo-T	B-T	
Parastrophia hemiplicata *Hall*	r	......	......	B-U	T	T	Baffin Land Lake Winnipeg
Protozyga exigua *Hall*	c	......	......	B-T	......	Lo-T	
Zygospira recurvirostris *Hall*	c	......	......	B-T	Lo-T	Lo-T	
Modiolopsis aviculoides *Hall*	r	......	......	T	......	......	
Whitella ventricosa *Hall* sp	......	......	rr	B-T	T	T ?	
Ctenodonta *sp. indet.*	......	......	rr	......	......	......	
C. *cf.* astartaeformis *Salter*	......	......	r	......	......	......	
Protowarthia cancellata *Hall* sp	......	......	r	T-L	T-L	B-R	
Conradella compressa *Conrad* sp	r	......	r	T	Lo-T	......	
Carinaropsis carinata *Hall*	c	r	r	T	......	......	
Lophospira bicincta *Hall* sp	c	......	r	T	Lo-T	Lo-T	
L. perangulata *Hall* sp	c	......	......	Lo	......	Lo	
Liospira americana *Billings* sp	......	......	rr	B-T	Lo-T	Lo-T	Baffin Land
L. subtilistriata *Hall* sp	cc	......	......	T base	......	......	
Clathrospira subconica *Hall*	c	......	......	T	Lo-L	Lo-R	
Trochonema umbilicatum *Hall* sp	c	......	......	Lo-T	Lo-T	Lo-T	Baffin Land
Eccyliopterus spiralis *sp. nov.*	......	......	rr	......	......	......	
Holopea paludiniformis *Hall*	......	......	rr	T	......	T	
Cyrtospira attenuata *sp. nov.*	rr	......	......	......	......	......	
Hyolithes rhine *sp. nov.*	rr	......	......	......	......	......	
Conularia trentonensis *Hall*	......	......	rr	T	......	......	
Spyroceras bilineatum *Hall* sp.	?	......	......	T	Lo-T	Lo-T	
S. *cf.* anellum *Conrad* sp	r	......	......	T	Lo-T	B-T	
Cyrtoceras subannulatum *Hall*	rr	......	......	T	Lo-T	......	
Zitteloceras hallianum *d'Orbigny* sp	......	......	rr	T	T	B	
Tretaspis reticulata *sp. nov.*	......	......	cc	......	......	......	*cf.* Tretaspis Europe
T. diademata *sp. nov*	......	......	rr	......	......	......	cf. Tretaspis Europe
Ampyx (Lonchodomas) hastatus *sp. nov*	......	r	cc	......	......	......	*cf.* Ampyx rostratus *Sars.* of Europe
Remopleurides linguatus *sp. nov.*	rr	r	cc	......	......	......	
R. tumidulus *sp. nov*	......	rr	......	......	......	......	
Isotelus maximus *Locke*	cc	......	c	B-L	T-L	T-R	Baffin Land Europe
Gerasaphes ulrichana *Clarke* sp	......	r	......	......	......	Lo-U	
Illaenus americanus *Billings*	c	......	c	Lo-T	T	T	Baffin Land Europe ?
Thaleops ovata *Conrad*	r	......	......	......	Lo	Lo	
Cyphaspis matutina *sp. nov*	......	......	r	......	......	......	
Bronteus lunatus *Billings*	......	......	rr	......	T	T	
Calymmene senaria *Conrad*	......	......	rr	T-L	T-L	T-R	
Pterygometopus eboraceus *Clarke*	r	......	......	T	......	......	
P. callicephalus *Hall*	c	r	c	T	T	Lo-T	
Ceraurus pleurexanthemus *Green* sp	c	......	c	T	Lo-L	Lo-T	
Dalmanites achates *Billings*	c	......	......	T	T	T	
Sphaerocoryphe major *sp. nov.*	......	......	r	......	......	......	Lake Winnipeg ?
Cybele *sp*	rr	......	......	......	......	......	
Leperditia fabulites *Conrad*	c	......	......	Lo-T	Lo-T ?	Lo	
L. resplendens *sp. nov*	cc	c	......	......	......	......	
Isochilina armata *var.* pygmaea *var. nov*	......	r	r	......	......	......	Isoch. armata Lo-B of N. Y.
Schmidtella crassimarginata *var.* ventrilabiata *var. nov*	......	cc	......	......	......	......	Sch. crassim Lo. in west
Primitia mundula *var.* jonesi *var. nov*	......	......	r	......	......	......	

Frequency and vertical range of species (*concluded*)

	Gray-lime stone	Reddish gray lime-stone	Black lime-stone	N. Y.	Canada	West	Other regions
Aparchites minutissimus *var.* robustus *var. nov*	......	....	c	....	....	....	
Eurychilina reticulata *Ulrich*	......	c	......	....	....	Lo-B	
E. bulbifera *sp. nov*	r	r	......	....	....	....	
E. (?) solida *sp. nov*	......	rr	......	....	....	....	
E. subradiata *var.* rensselaerica *var. nov*	c	c	......	....	....	....	E. subradiata Lo.
E. obliqua *sp. nov*	rr	....	......	....	....	....	
E. dianthus *sp. nov*	c	....	......	....	....	....	
Bollia cornucopiae *sp. nov*	rr	....	......	....	....	....	
Macronotella ulrichi *sp. nov*	c	....	......	....	....	....	
M. fragaria *sp. nov*	rr	....	......	....	....	....	
Bythocypris cylindrica *Hall* sp.	c	cc	r	....	U	T-U	

TAXONOMIC RELATIONS OF THE FAUNAS

Compact black limestone

A comparative study of the vertical ranges of these fossils gives the following results for the fauna of the black compact limestone pebbles (group 5).

In this compilation of the vertical ranges, the more complete data obtained by the careful investigations of the western lower Siluric faunas by Clarke, James, Miller, Sardeson, Schuchert, Ulrich, Winchell, and others, have been largely used, as the New York lower Siluric faunas, since the days of Hall's preparation of the first volume, *Paleontology of New York*, have been practically left untouched, and the very important work of the exact fixation of the ranges of the lower Siluric forms and of the more definite subdivision of the beds has only lately begun. It is therefore assumed that forms which in the west or in Canada have been found to reach below or above their zone in New York, will with farther investigation also be found to have a wider range in this state. A glance at the preceding table will show that a great number of forms reported only from the Trenton of New York and Canada, are claimed to occur in the Ohio and upper Mississippi basins in beds corresponding to the Lowville and Black river limestones. This is evidently due to the relatively poor development of these last two terranes in the east.

D i p l o g r a p t u s f o l i a c e u s passes from the Chazy into

the Lorraine, Rafinesquina alternata in Canada from the Chazy into the Lorraine, Platystrophia biforata from the Chazy in Canada to the upper Siluric in the west.

These, as well as the new forms, can therefore be excluded as furnishing no data for the determination of the taxonomic position of this fauna. Also Climacograptus scharenbergi is of no use for this purpose, as it has hitherto been found only in another facies, the Quebec and Normans kill shales, and Stictopora cf. elegantula, Crania cf. trentonensis, Siphonotreta cf. minnesotensis, and Conularia cf. trentonensis are not positively identified. Of the remaining members of the fauna, Plectambonites sericea, Dalmanella testudinaria, Ceraurus pleurexanthemus range from the Lowville limestone to the Lorraine or Richmond beds. Orthis tricenaria, Lophospira bicincta, Liospira americana, Illaenus americanus and Pterygometopus callicephalus begin in the Lowville beds and rise into the Trenton. These, together with all the forms mentioned below which are younger, prove the black compact limestone to be younger than the Chazy, in spite of the Chazy aspect of some of its trilobites. Stomatopora inflata, Callopora multitabulata, Whitella ventricosa, Protowarthia cancellata, Isotelus maximus lived either in New York, Canada or the west from the Black river into the Trenton period. Streptelasma corniculum, Pholidops trentonensis, Leptaena rhomboidalis, Conradella compressa, Carinaropsis carinata, Zitteloceras hallianum, Calymmene senaria, Bronteus lunatus and Bythocypris cylindrica have not yet been found below the Trenton. None of the species obtained from the black compact limestone is restricted to the Lowville or Black river limestone; it must, therefore, be concluded, that these pebbles are of Trenton age. The inquiry for the more precise location of the bed within the Trenton terrane meets with the greatest difficulty from the lack

of any definite facts as to the exact location and range of the Trenton fossils in the various outcrops within the state.

Of the fossils enumerated, those entering the Trenton or beginning in the Trenton would be available for an analysis; of these, however, Leptaena rhomboidalis, Lophospira bicincta, Liospira americana, Pterygometopus callicephalus, Stomatopora inflata, Whitella ventricosa, Protowarthia cancellata, Isotelus maximus, Illaenus americanus, Conradella compressa, Calymmene senaria, Bythocypris cylindrica are found to occur in one or another locality of the lower, middle or upper Trenton, and are thus unable to give the desired clue. Of the remaining species, Streptelasma corniculum is reported by Hall to occur principally in the lower Trenton, Orthis tricenaria in the lower Trenton in New York, while in Minnesota it is also found in the middle third of the Trenton; Callopora multitabulata is in Minnesota positively known from the lower Trenton and doubtfully from the middle Trenton, Pholidops trentonensis is of uncertain position at Middleville, a small variety of the same species is however in the west restricted to the lower Trenton, Carinaropsis carinata probably is restricted to the lower and middle Trenton of New York; and Zitteloceras hallianum is a Black river fossil in the west and was known to Hall only from the lower Trenton at Middleville.

Bronteus lunatus was described by Billings from the Trenton of Ottawa; according to the *Geology of Canada* (p. 177) it is associated there with a most remarkable fauna of crinoids and asteroids, only about 150 feet below the base of the Utica beds, while in the same work (p. 173) it is also reported from Murray bay together with such lower Trenton forms as Orthis tricenaria, Dinorthis pectinella, in a section giving 200 feet of limestone above the Black river beds. It appears, hence, to occur in the lower and upper third of the Trenton, while Clarke reports it also from the middle third of the

Trenton in Minnesota. Isochilina armata Walcott, var. pygmaea is a variety of a species which has been found by its discoverer only in the Lowville and Black river limestone of Russia, Herkimer co., while Primitia mundula and Aparchites minutissimus are later forms with prenuncial varieties in the Trenton. The evidence afforded by these fossils is obviously strongly indicative of lower Trenton age of the compact black limestone; for it must be considered that the great majority of the forms begin in the Lowville and Black river limestone and rise into the Trenton, while few begin in the Trenton and have their principal development in younger beds; some forms, as Streptelasma corniculum, Callopora multitabulata, Zitteloceras hallianum, and Isochilina armata var. pygmaea, can be regarded as restricted to the lower Trenton, or having their principal development there. The general appearance of the fauna of the compact black limestone pebbles, is hence, such as points more to a close relation with faunas older than the Trenton, than with younger faunas, and is, in a general sense, indicative of lower Trenton age.

Reddish gray and gray pebbles

A comparison of the faunas of the compact reddish gray (group 6) and of the gray crystalline limestone (group 7) pebbles shows that the two differ only in their ostracode element; the reddish gray limestone contains only a few other fossils, all of which, with the exception of Ampyx hastatus, Gerasaphes ulrichana, Pterygometopus callicephalus, occur also in the gray limestone. The ostracodes peculiar to the reddish gray limestone are either new species or new varieties, with the exception of Eurychilina reticulata. As, further, lithologic transitions from one to the other occur in the same pebble, it is apparent that both are derived from adjoining or alternating beds, and that it will serve our purpose to treat both faunas together.

Of the large number of species identified in these pebbles, the new species and Rafinesquina alternata, on

account of its great vertical range, will be left out of consideration. Also, Modiolopsis cf. aviculoides and Spyroceras cf. anellus are of little taxonomic value, being poorly represented and not positively identified.

Orthis tricenaria, Dalmanella testudinaria, D. subaequata var. pervetus Conrad, Plectorthis plicatella, Dinorthis pectinella, Protozyga exigua, Zygospira recurvirostris, Lophospira bicincta, Clathrospira subconica, Trochonema umbilicatum, Gerasaphes ulrichana, Illaenus americanus, Pterygometopus callicephalus, Ceraurus pleurexanthemus and Leperditia fabulites extend partly in the eastern and partly in the western province, from the Lowville limestone into or above the Trenton limestone, and serve, in the determination of the age of the pebbles under consideration, by a process of elimination, to prove that the fauna to which they belong originated in the Trenton period, and may belong either to the Lowville, Black river, or Trenton epochs. Parastrophia hemiplicata ranges from the Black river into the Utica beds, Conradella compressa from the Black river into Trenton beds, Isotelus maximus from the Black river into the Richmond beds.

Several members of the fauna of the gray limestone pebbles are thus far known only from the oldest epochs of the Trenton period; these are Lophospira perangulata Hall sp. Hall comprised two different forms under this one specific term; that found in the conglomerate agrees more with the Lowville limestone type than with the Trenton limestone type. Thaleops ovata occurs in the west only in beds of Lowville limestone age, and in Canada in beds in which the Lowville and Black river stages have not been separated.

Isochilina armata var. pygmaea is a variety of a species found by Walcott in the Black river and Lowville limestones, Schmidtella crassimarginata var. ventrilabiata, and Eurychilina subradiata var.

rensselaerica are slightly differing eastern representatives of western Lowville limestone forms, while Eurychilina reticulata is known only from the Lowville and Black river limestones[1].

There are, on the other hand, a number of forms which combat a conclusion based on the evidence just cited. These are: Rafinesquina deltoidea, reported from the Trenton of New York, Canada and the west; Triplecia nucleus, Carinaropsis carinata, Liospira subtilistriata, Pterygometopus eboraceus, Dalmanites achates, which are as yet known only from the Trenton limestone; Leptaena rhomboidalis and Bythocypris cylindrica, which begin in the Trenton and extend upward. Of these Rafinesquina deltoidea is only weakly represented by a form showing certain varietal differences in the suppression of the intermediate finer striae and concentric wrinkles on the disk, and is therefore probably not to be relied on as a safe indicator of the taxonomic relations of the beds under consideration; Triplecia nucleus, Carinaropsis carinata, Liospira subtilistriata and Pterygometopus eboraceus are not reported from extralimital localities, and, considering the fact that in New York the Lowville and Black river faunas are rather meager, and have been thoroughly investigated in but a few localities, they may possibly go below the Trenton limestone. This is specially probable in the case of Liospira subtilistriata, which is reported by Hall as occurring only near the base of the Trenton limestone at Watertown; but as Triplecia nucleus, Carinaropsis carinata and Liospira subtilistriata are characteristically developed and common in the limestone pebbles, they must be considered as important factors of the fauna of the latter and, with our present knowledge of their ranges, as indicative of the Trenton age of the gray limestone. Pterygometopus eboraceus has thus far

[1] The specimen from the Onondaga chert of New York referred by Jones (Quar. jour. geol. soc. 1890. 46:593) to this species is considered by Ulrich as specifically if not generically different.

been found only in one specimen in the Trenton of Saratoga county, and, for this reason, has little taxonomic weight, while Dalmanites achates, Leptaena rhomboidalis and Bythocypris cylindrica, having a wider distribution, must be considered as strongly supporting the view of the Trenton age of this fauna, suggested by the fossils just named.

In weighing the evidence furnished by the two groups of fossils, those which have their typical development in the lower epochs of the Trenton period, and those which are restricted to the Trenton limestone itself, it is to be considered that the Lowville and Black river limestone element is largely represented by ostracodes which, having been carefully studied in the west and found to be quite markedly restricted to certain horizons, must be regarded as fairly reliable horizon-markers. The forms from the conglomerate bed of Rysedorph hill, however, show, with the exception of Eurychilina reticulata, certain differences from the western types which, it is true, may be more the expression of difference of province than of epoch, but, in the face of the strong Trenton limestone element with which they are associated, can not be considered as furnishing conclusive evidence.

We have therefore somewhat conflicting evidence as to the age of these beds, which in the writer's opinion is due partly to the fact that the ostracode forms of the Trenton limestone of New York have not yet been thoroughly collected and studied, and partly due to the smallness of the fauna known as yet from the Lowville and Black river limestones of this state, specially from the former. All that can be said, therefore, at present in regard to the taxonomic relations of the fauna of the gray crystalline and associated reddish gray compact limestone pebbles is that they contain a Trenton fauna, with a strong Lowville and Black river element, and that, on this account, they evidently must be placed within the lowest Trenton; a conclusion which seems to be strengthened by the presence of a number of forms of lower Trenton occurrence, and the fact that the great majority of all forms observed range from the Lowville to the

Trenton limestone, instead of ranging from the Trenton limestone upward, so that the general aspect of the whole assemblage of forms is decidedly that of a fauna of the lower and middle part of the Trenton period.

Relative position of the black and gray Trenton limestones

In regard to the relative original position of the black compact Trenton limestone and gray crystalline and reddish gray compact Trenton limestone, which are mixed in the conglomerate, it is to be remembered that the black limestone pebbles, in spite of their strong admixture of strange types such as Ampyx and Remopleurides, fail to show such a decided Lowville and Black river limestone element as the gray limestone, and therefore should be considered younger than the latter. This conclusion is supported by the observation of several members of the black limestone fauna in the matrix of the conglomerate at the Moordener kill and at Schodack Landing, as shown in the following tabulation.

Fauna of matrix

	Moordener kill	Schodack landing [1]	Occurrence of fossils in pebbles
Streptelasma corniculum	....	+	black Trenton limestone
Pachydictya *sp*	+	......	
Stromatocerium *sp*	+	......	
Rafinesquina alternata	+	+	black and gray Trenton limestone
Strophomena incurvata	+	......	
Plectambonites sericeus *var.* asper	+	+	gray crystalline Trenton limestone
P. pisum	+	+	black Trenton limestone
Orthis tricenaria	....	+	black Trenton limestone
Pterygometopus callicephalus	+	......	gray and black Trenton limestone

This faunule would suggest that the conglomerate beds were formed at a time when the organisms found in the black compact limestone were still flourishing, and that both must be considered as falling within the same epoch, viz the lower Trenton.

[1] The matrix of the Rysedorph hill conglomerate, which is more sandy than that of the more southern exposures, is filled only with comminuted fragments of Rafinesquina alternata, Plectambonites sericeus, etc.

Some other observations materially support this conclusion. Foremost of these is the occurrence of Climacograptus scharenbergi in the black limestone. This graptolite, as already remarked in another paper, is a typical form of the lower and upper Dicellograptus zones in Canada, and of the corresponding beds in Great Britain, and is in New York restricted to the lower Dicellograptus zone or Normans kill shale. As the conglomerate bed is intercalated in this shale, it is evident that the formation of the conglomerate and of the shale are, geologically speaking, contemporaneous, and, as this graptolite of small vertical range occurs also in the black limestone pebbles, the formation of that limestone must also be nearly contemporaneous with, or, more exactly speaking, precede the formation of the conglomerate within the same subdivision of the Trenton limestone epoch.

The formation of that part of the Normans kill shale lying below the conglomerate bed, and of the black Trenton limestone have, in the writer's opinion, been synchronous and going on in adjacent regions, the black limestone representing the limestone facies corresponding to the shaly Normans kill graptolite facies.

The remarkable coincidence of the existence of numerous faunistic elements, strange to the continental Trenton of North America, in both the shales and the black limestone, will be further discussed in the next section, but may be mentioned here as additional argument in favor of the equivalency of the faunas of the Normans kill shales, and of the black Trenton limestone of the conglomerate.

Faunistic difference between the lower Trenton of New York and the west

In a previous paper the writer has already discussed the difference in sedimentation and fauna between the lower Trenton as represented by the Normans kill graptolite shales of the Appalachian region and lower Canada and the lower Trenton limestone of the regions farther west.

The observation of a succession of terranes from west to east in Albany county, which proved to represent the Lorraine, Utica, middle Trenton and Normans kill graptolite epochs, forms the basis of the claim that the last must be homotaxial with part of the lower Trenton limestone of the regions farther west. It was further demonstrated by the observations of Prosser and Cumings that the Trenton limestone thins out gradually from the type section at Trenton Falls toward the Hudson river, while at the other side of that river, according to the observations of Walcott, Dwight and Dale, the Trenton epoch is only slightly represented by calcareous deposits, and these most probably belong only to the lowest Trenton. It is, hence, quite certain that the Trenton in this part of the Appalachian region is largely represented by clastic sediments.

This distinct lithologic development is associated with an entirely different faunistic facies, the Normans kill graptolites in association with a few small brachiopods constituting the only evidences of life in these lower Trenton shales. It has been pointed out that this peculiar graptolitic fauna has been traced from Lower Canada, where it was studied by Lapworth, through Maine, Vermont, and along the Hudson river in New York, and probably, as maintained by Emmons, extends as far as Virginia. While it has been identified by Lapworth with a fauna of wide extent in the lower Siluric of Great Britain and Scandinavia, it has not been recognized in its typical development west of the Appalachian region, though apparently reappearing in Arkansas and British Columbia. The consensus of opinion of recent writers on this graptolite fauna is that it was of oceanic and probably planktonic habitat. Its distribution on both sides of the Atlantic basin indicates its extent over a large part of that basin. The black bands filled with graptolites are in most of the localities, hidden away in a huge mass of more sandy shales and thin beds of sandstone, suggesting thus that the myriads of these living beings were swept together only accidentally. The astonishing scarcity of complete colonies among the endless numbers of

rhabdosomes of a considerable number of species[1] is a forcible indication that they had fallen to the sea floor and drifted about outside of their habitat. The assumption that the rhabdosomes were carried by currents either oceanic, tidal or coastal, and deposited, as suggested by Lapworth, in the quiet water at a certain, more or less uniform, distance from the coast, can therefore not be far from the truth. We must conclude from their meridional distribution that they were brought into the Appalachian region from the Atlantic basin, while the far west received them from the Pacific basin.

Lower Trenton faunas of the central and eastern coastal regions with European elements

The question of the probable route along which this incursion took place, may at present be disregarded, and the mere fact be emphasized that there exists a wide difference between the fauna and sedimentation of part of the lower Trenton in the eastern coastal region, and that of the eastern inland region. This difference may be only one of facies, that is, a difference in faunal composition causally connected with the difference in sedimentation, and may indicate nothing but difference of depth, distance from the coast line or swiftness of current, such differences as are found within close limits along all coasts, and affect only small areas. Or it may be one of provincial importance caused by the differences of the conditions existing between different parts of the ocean, or the latter and its border seas.

The wide extent of the Normans kill graptolite fauna and its restriction to the eastern continental borders on one hand, and the greater extension of the synchronous Trenton limestone and its restriction to the continental platform, suggest that we have here a difference of provincial importance. It is therefore a fact of much interest that there is found entombed in the conglomerate a limestone fauna which must have existed shortly

[1] To illustrate this scarcity of colonies, it may be mentioned that in a dozen boxes of selected material secured in a week's collecting at Mt Moreno near Hudson, not a single colony was found, though all the species of the horizon are represented by rhabdosomes in finely preserved state. The same experience has been repeatedly met with by the writer, as well as others, in all localities of this zone.

before or contemporaneously with the lower part of the shale, as indicated by the presence of one of the characteristic graptolites of the shales and the lower Trenton aspect of the entire assemblage. In this limestone fauna, then, we have a direct means of comparing lower Trenton forms of the eastern border and of the continental sea, living in the same bathymetric zones and under the same marine conditions, and of determining whether the incursion of the eastern graptolite fauna into the continental border sea indicates the opening of an entirely new but temporary connection with the Atlantic ocean, or whether Atlantic, or rather European connections have had an appreciable influence also on the faunas of the limestone-depositing Trenton sea. The latter suggestion is in a certain measure supported by the appearance of the Normans kill graptolites in the limestone, but, in order to establish the conclusion, it is, in the writer's belief, fully demonstrated by a number of other fossils appearing in the limestone.

The species on which this conclusion is mainly based are, besides the above mentioned graptolites, whose habitat is the eastern border region and northern Europe: Christiania trentonensis sp. nov., which is well represented in the lower Siluric of Europe, by closely similar species, though in America only known heretofore by a Helderbergian species; the two species of Tretaspis, a genus unrepresented in the American Trenton fauna but widely and richly represented by allied species in the lower Siluric terranes of Great Britain, Bohemia and Scandinavia; Ampyx hastatus, which belongs to a subdivision of that genus (Lonchodomas), not represented in the Trenton of North America, but present at this time in northern Europe (Ampyx rostratus); the species of Remopleurides, which have not been found in the central continental region; the Sphaerocoryphe, which thus far is definitely known only from this locality, and which also is a foreign element to the Trenton of North America. Remopleurides striatulus Walcott, and Sphaerocoryphe robustus Walcott, occur at Trenton Falls only in higher

beds, but have not been observed farther west. They are evidently survivors clinging to the eastern region. The pygidia of Cybele observed at Rysedorph hill and stage N of the Quebec group in Newfoundland belong to forms closely related, if not identical with the European Cybele verrucosa.

There are still other differences in these faunas manifested in the distribution of forms known before. Thus the genus Triplecia, occurring in the lower Trenton pebbles of Rysedorph hill, is represented in the Trenton of New York by three species, while, according to Schuchert's *Synopsis of American fossil Brachiopoda* and Winchell and Ulrich's lists, it is not found in Trenton beds west of New York, but appears in the central region in Lorraine time and continues into the Niagara period. In Europe several species from the lower Siluric have been referred to this genus, one of which, Triplecia spiriferoides McCoy, from the homotaxial Llandeilo, belongs to the radiated group represented in the eastern Beekmantown limestone. Orthis insularis Eichwald is also regarded as a Triplecia by Hall and Clarke. This ranges from the Llandeilo to the upper Llandovery. It is therefore probable that the peculiar distribution of this genus in the Trenton of America indicates zoogeographic differences between the eastern border and the more continental Trenton, due to the exchange with the faunas of more easterly regions.

Trinucleus concentricus has been recorded from the lower Trenton of New York (White, p. 84) and abounds in the upper strata of this formation, but it does not appear as a Trenton species in the lists of Minnesota fossils given by Winchell, Ulrich and Clarke. In the Ohio valley it pertains to the upper beds only (i. e. upper Trenton and Richmond). This species seems to have slowly spread from east to west into the continental basin. No other species of this genus is known in the North American lower Siluric, with the exception of a small Utica form, separated by Ulrich, while in Europe quite a number of lower Siluric species have been described. These facts appear

to indicate that this genus had its center of development farther east, either in the Atlantic or in northern Europe.[1]

ORIGIN OF THE CONGLOMERATE

The origin and composition of the conglomerate bed, whose fauna has here been investigated, invites some farther remarks. The bed is composed of pebbles of lower Cambric, Chazy, Beekmantown and lower Trenton age. The explanation of this remarkable accumulation is largely to be found through an inquiry into the direction whence these pebbles came.

The extremely rare lower Cambric pebbles are identical with those of the lower Cambric conglomerate exposed at Troy and Schodack Landing. They may therefore be derived either from that conglomerate bed or from the mother bed of that conglomerate. They can not be derived from the west or northwest, as no lower Cambric beds are known in those directions, while they are known in the regions to the north and east. Neither is the Chazy known farther west, nor in the Mohawk region; it extends largely to the north in the Champlain region and is quite certainly present in the limestones of the Taconic region. The Lowville limestone and gray lower Trenton limestone pebbles may be derived from the west. It is not to be assumed that the materials of the conglomerate were gathered from different or even opposite directions; and, as the lower Trenton is also well exposed to the north and south, and is supposed to form a part of the metamorphic rocks in the Taconic region to the east, it is more than probable that these were derived from the east or north rather than from the west. Finally the black Trenton lime-

[1] The forms cited here constitute an element in the Trenton fauna of eastern America which is evidently more fully represented in the homotaxial beds of northern Europe. As the latter, and specially the European northwest, was at that time a part of the Atlantic basin, the presence of these forms must be taken to indicate some connection of the continental Trenton sea with the Atlantic in the northeast.

If the "Grönländischer continent", supposed by Prof. Frech to have extended in lower Siluric time across the present northern Atlantic from Baffin Land and Labrador to Scotland and Scandinavia, was a reality, its southern coast would have furnished either the center of development or the highway for the migrations of these forms and many others, as *Asaphus gigas*, *Calymmene senaria*, *Plectambonites sericeus*, *Platystrophia biforata*, *Dalmanella testudinaria*, *Orthis tricenaria*, *Leptaena rhomboidalis*, which appear in lower Siluric time on both sides of the Atlantic.

stone pebbles, with their peculiar faunal elements, are quite distinct from the Trenton exposed in the Mohawk valley, nor have similar Trenton fossils been recorded from more northerly, or southerly localities.

The sum of the evidence points, therefore, to an origin of the conglomerate pebbles from a direction other than the west, or to the area of Appalachian folding between the lower Mohawk and Taconic mountains.

The tectonic events of lower Siluric time have been described with a master's hand by Dana:

> The era of limestone-making and therefore of continental seas, largely free from sediments, which made progress in the Canadian period, reached its culmination in the earlier division of the Trenton period, when limestones were almost the only kind of rock being deposited over the breadth of the continent. The absence of sediments from a large part of the continental region must have been owing to the absence of the conditions on which their distribution depends. The currents of the ocean which ordinarily swept over the land (the Labrador currents from the north, along the eastern borders, and the Gulf stream from the south, over the interior) must have had their action partly suspended. This may have been caused by a barrier outside of the limestone area, near or outside of the present Atlantic coast line. If the land in the shallow region outside of the present Atlantic border of the continent, were above tide level at the time, it would have been a continental barrier against both waves and currents.
>
> With the opening of the Hudson river era, sediments again were deposited over New York and the Appalachians, and some change of level had therefore taken place. But, as the formation of the limestones was continued in the Missisippi basin, and also in the St Lawrence bay (at Anticosti), the change did not affect essentially these regions. If the Atlantic barrier above alluded to were a fact in the Trenton era, an oscillation of level submerging it, and raising toward the surface another parallel region more to the west, where the Appalachians now stand, would have opened again the New York and Appalachian area to the ocean, and so might have occasioned the transition to sedimentary accumulations.

The barrier, assumed by this profound student, to account for the undisturbed deposition of the lower Lower Siluric up to the

end of the Trenton, is represented by Frech on his chart[1] drawn to explain the complete faunistic differentiation of the American continental and North Atlantic basins from the beginning of the lower Siluric to the end of the Black river limestone period. Frech there assumes an oceanic transgression in the Appalachian regions to connect the Trenton with the European faunas, while Dana has the barrier migrate westward at the end of the Trenton period to explain the transition to clastic accumulations. The writer in the foregoing chapters, has brought more evidence to demonstrate the ingress of Atlantic forms into the eastern part of the Trenton basin at the beginning of the Trenton period, and has elsewhere shown that, in this part of eastern New York or in those parts of the Appalachian area where the Normans kill shale is found, the transition to the deposition of clastic sediment began in the early Trenton period and not toward its end.

If we attempt to apply to our investigation into the origin of the conglomerate the theories set forth by these authors, we may infer that at the beginning of the Trenton period the deposition of limestone continued for a short period in this region, and the material of the gray limestone pebbles of lowest Trenton aspect was formed; that at this time, by the incipient transgression of the ocean over the eastern barrier, the influence of north Atlantic forms began, becoming more pronounced at the time of the deposition of the black limestone; that, at the same time, the gradual rising of the more westerly parallel barrier in the Appalachian region, together with the numerous Archaean islands assumed by Dana, furnished the material for the long belt of Normans kill shale and the conglomerate bed. The very extension of the Normans kill shale from north to south would indicate the direction of this barrier and of the intercalated conglomerate bed as that of a probable coast line.

This attempt to account for the presence and the peculiarities of the conglomerate bed is partly supported by a view advanced by Walcott to explain the origin of intraformational conglomerate beds of Cambric and earliest lower Siluric age observed

---

1 Roemer & Frech. Lethaea palaeozica. 1897. v. 3, Karte 2.

in a number of localities in the Appalachian region[1]. The occurrence of conglomerate beds resting on the limestones from which they were derived, suggested to that experienced observer that the sea bed was raised in ridges or domes above the sealevel, and thus subjected to the action of seashore ice, if present, and the aerial agents of erosion. While no direct connection has been noted between the lower Trenton conglomerate and the youngest limestone bed represented in it, the assumption of the presence of such ridges or domes in the Appalachian region is in accord with our knowledge of the constant movements going on in this region throughout the Paleozoic era, and coincides with the assumption of barriers in this region made by other writers. It is therefore quite possible that the assumed transgressions opened the crest of one of these ridges or domes, and thus laid bare at once to the abrading action of the waves, a series of beds extending from the Cambric to the last deposited Trenton limestone, and furnished the various materials for the conglomerate and the calcareo-arenaceous mud of the matrix. These were deposited on the Normans kill shales forming in the deeper water.

While the presence of temporary coast lines, or the exposures of the various beds represented by the pebbles, to wave action, caused by the rising of broad ridges to the surface of the lower Trenton sea, may be inferred with some degree of certainty, the great variation in the size of the boulders and pebbles presents some difficulty to these attempts at explanation. Some of the boulders attain a diameter of several feet. The action of coast ice, appealed to by Dawson for the explanation of the lower Siluric conglomerates near the St Lawrence river and suggested by Walcott as an alternative theory for the origin of some of the Cambric conglomerates, may in the writer's judgment be excluded here on account of the presence of the Trenton fossils, including corals, in the matrix. But it is highly probable that the action of strong tidal or coastal currents, caused by the oblique impact of the waves on the coast, was engaged in spreading the material derived from the coastal or abraded region over a

[1] Geol. soc. Am. Bul. 1893. 5:191.

large area, as suggested by the relative thinness of the bed, and the transportation of large boulders. It is a matter of repeated observation that shingle, often of considerable size, is distributed widely along the coasts, when the two kinds of currents mentioned above are able to display their full force. The boulders and pebbles transported by such currents are reported to be of different size, varying according to their relative hardness. As the largest boulders in the conglomerate consist of very hard Lowville limestone, and the smaller ones of more friable sandstone or more brittle, black crystalline Trenton limestone and of softer gray Trenton limestone, the common conditions prevailing along the coast of an open sea seem to be sufficient to explain the phenomena of the Rysedorph hill conglomerate.

It has been lately urged by Gilbert van Ingen[1] that certain unsorted deposits, observed by Kümmel, Weller and himself in New Jersey, should not be considered as of submarine origin, but rather as flood plain deposits. The writer is convinced that this view will greatly aid in understanding the barren measures of several of our formations, but does not believe that it could be applied to the explanation of the Rysedorph hill conglomerate, for the following reasons:

The matrix of the conglomerate has been found to contain marine fossils, the bed is only relatively thin and intercalated in distinctly marine deposits; and, the Rysedorph hill beds show distinctly long strings of pebbles which indicate a certain assortment of the material. In some places these pebbles are still angular and appear as if belonging to a continuous bed broken up and at once recemented.

Other Trenton conglomerates

The extension of this conglomerate bed north and south beyond the localities described will be a subject for farther investigation. Prof. Dana and Prof. Dwight have made known the presence of a Trenton limestone farther south which is described as having

[1] N. Y. acad. sci. Oct. 15, 1900; Am. geol. Jan. 1901, p. 43.

a brecciated appearance. The Canadian geologists report the presence of conglomerate bands in the synchronous graptolite shale of Quebec; and Mr Kümmel and Dr Weller have discovered a conglomerate bed at the base of the Trenton in New Jersey. It is, however, more than doubtful that these occurrences have any relation to the bed in Rensselaer county, specially as the New Jersey conglomerate is considered a basal conglomerate, and that of Rysedorph hill is evidently intraformational, containing pebbles of the same epoch and intercalated in shales of the same epoch. It has, however, been demonstrated that a continuous stratum of conglomerate, over which, on a sinking coast, younger deposits creep, may belong to many successive horizons. This has been most clearly pointed out by De la Bèche in the southwest of England[1]. The New Jersey conglomerate may therefore be only apparently basal and actually synchronous with the more northern one.

As the study of the conglomerate beds of various formations and the investigation of the conditions along coasts where such beds are formed, has furnished ample evidence that conglomerates are the most inconsistent of all sedimentary formations, usually sinking or swelling up suddenly, thinning out and reappearing, it is also to be assumed *a priori* that the bed extending from Rysedorph hill to Schodack Landing is not of such a wide extent as to allow its connection with the beds of Quebec or New Jersey.

However that may be, the Rysedorph hill conglomerate continues to be remarkable as an intraformational conglomerate. A conglomerate, according to the experience of geologists, generally indicates a break in the continuity of the sedimentation, an erosion of a preexisting formation and, therewith, an important change in the physical conditions of the region. The writer feels however that the presence of true intraformational conglomerates in the Cambric and lowest lower Siluric of the Appalachian region has been so distinctly and vividly set forth by Walcott[2] that no reasonable doubt of the existence of this phe-

[1] Geikie. Textbook of geology. 1893. p. 516.

[2] Geol. soc. Am. Bul. 1893. 5:191.

nomenon in this region, and even in Cambric beds close to the Trenton conglomerate, can be entertained. Farther, the inferences as to the origin of the intraformational conglomerate drawn by Mr Walcott from observations extended over the whole Appalachian region, seem to be applicable to the Rysedorph hill conglomerate. Mr Walcott had the opportunity of observing the relation of the bedded limestone to the superjacent conglomerate, a relation which proved that the calcareous mud which was subsequently consolidated into the limestone, solidified soon after deposition. "This is shown by the presence in the conglomerate of rounded pebbles and angular fragments of limestone with sharp clear-cut edges." The same observation has been made in the Rysedorph hill conglomerate as to the lower Trenton pebbles; and, as the same fauna has been found by the writer in the matrix and in one of the groups of limestone pebbles, the calcareous mud composing those pebbles must have consolidated during the continued existence of that fauna.

SUMMARY

1 The investigation of the lower Siluric shales of the neighborhood of Albany has led to the observation of a conglomerate bed embedded in these shales and outcropping on Rysedorph hill near Rensselaer, on the Moordener kill near Castleton and at Schodack Landing.

2 The most interesting feature of this conglomerate is the fauna which the component pebbles and the matrix contain. To describe these and to obtain from them conclusive data as to the age of the inclosing Normans kill shales is the principal purpose of this paper.

3 The conglomerate contains a great variety of pebbles. In the southern outcrops, at Schodack Landing, nonfossiliferous sandstone pebbles prevail; going northward, fossiliferous limestone pebbles increase, and on Rysedorph hill they are the principal components.

4 The limestone pebbles are shown by their faunas to be derived, in very small number, from Cambric and Chazy rocks;

more frequently from the Lowville limestone; and prevailingly from extremely fossiliferous black and gray limestone beds which are of lower or lowest Trenton age.

5 A specially interesting feature of the fauna of these Trenton pebbles was found in the considerable number of new forms, largely brachipods, trilobites and ostracodes. Some of these belong to genera new to the American Trenton but well represented by very similar forms in equivalent north European beds. These, as well as several other forms which also occur in the Rysedorph hill conglomerate and are restricted to the eastern Trenton, support the conclusion derived from the distribution of the Normans kill graptolite shales, viz that in lower Trenton time the eastern Trenton sea had attained connection with the Atlantic.

6 As the fauna of the Trenton pebbles is in marked features different from that of the beds known in the Mohawk and Hudson valleys, it is supposed that the material was derived from the regions to the east and northeast, where the Trenton beds have now become metamorphosed and the fossils obliterated.

7 The occurrence of the lower Trenton limestone pebbles in this region is taken to indicate that at the beginning of the Trenton period the quiet limestone-depositing Trenton sea extended also over this region; while the presence of the Normans kill shale of lower Trenton age proves that this favorable condition soon came to an end, and a radical change in the physical conditions took place.

8 The conglomerate itself is intraformational. It is embedded in shale of the same age, and the fauna of the matrix of the conglomerate is of lower Trenton age. The conglomerate, therefore, evidently does not mark any important change in the physical conditions of the region, but is probably due to a temporary elevation of a low Appalachian ridge into the sphere of wave action.

LIMESTONES OF CENTRAL AND WESTERN NEW YORK

INTERBEDDED WITH

BITUMINOUS SHALES OF THE MARCELLUS STAGE

WITH NOTES ON THE NATURE AND ORIGIN OF THEIR FAUNAS

BY JOHN M. CLARKE

Plate 8

The peculiar aspect of the fauna accompanying the dark Marcellus shales is familiar to every field worker in the geology of New York. It is a small congeries of diminutive and tenuous shelled creatures, such as Orbiculoidea minuta, Chonetes mucronatus, Liorhynchus limitare among the brachiopods, Actinopteria muricata, Pterochaenia fragilis and a few other shells among the lamellibranchs, usually referred to Lunulicardium and Panenka, the cephalopods Orthoceras subulatum, Parodiceras, and the pteropod Styliolina fissurella in great abundance. In all bituminous beds of like character in the older paleozoic there is a certain uniformity of expression in the faunas, a sort of convergence, no doubt induced in considerable measure by the circumstances under which the sediments were deposited and the organisms have existed. The latter, whatever their zoologic position, show evidence both in their small form and thin shell of having yielded in some degree to the unfavorable influences of a shallow sea in its influx on the epicontinental plateau. It is quite evident that the fauna, small as it is, is not homogeneous and can not represent a single bathymetric facies. We shall observe from the considerations following that, as a whole the fauna was introduced within the confines of New York before the cessation of Onondaga limestone deposition; furthermore present evidence seems to indicate that it was an invader from the southeast along the inner or Appalachian face of the interior sea.

In the common and historic employment of the term Marcellus shales as an expression of a lithologic unit, it has been usage to include therein whatever slight variation in sedimentation these

black shales may carry with them, and, so far as the main body of the formation is concerned, these variations consist in the appearance now and again of calcareous banks at various altitudes from the base of the formation, but more notably predominant toward the lower part of the mass.

All through the country west of Onondaga county the passage of the black shale upward is so gradual and the diminution of its bituminous matter so almost imperceptible that no division line between the Marcellus and Hamilton deposits is practicable, and no successful attempt has yet been made to delimit the two. Hence naturally a discrepancy appears in the assignments which have been made now and again of the thickness of the Marcellus deposits throughout this region.

From Onondaga county to Lake Erie the bituminous shales pass upward into and are overlain by a heavy mass of blue and barren shales, shown by the section in the Livonia salt shaft to be fully 200 feet thick, and these carry in regularly diminishing degree the characteristic species of the dark beds below.

The limestone beds which invite special attention at this occasion constitute two notable banks, both of which have accepted appellations, one the "Goniatite" or Agoniatites limestone, the other the Stafford limestone. These are persistent over very considerable distances along the strike, one of them curiously enough disappearing from the strata where the other makes its first appearance. The former (Agoniatite limestone) extends from Schoharie county on the east to about the meridian of Phelps, Ontario co., and the latter from Phelps to Lake Erie. There are at various exposures of the Marcellus shales other more restricted manifestations of calcareous deposits in thin beds which have afforded some interesting faunal variations. These will be briefly noticed in the following passages.

Evidence of the two chief limestone banks above noted was recorded by the early geologists, the Stafford limestone in the sections given by Prof. Hall[1], and the Agoniatite limestone in the descriptions by Vanuxem[2]. Though mentioned incidentally

[1] Geol. N. Y. 4th geol. dist. 1843. p. 178, 179, 183.

[2] Geol. N. Y. 3d geol. dist. 1842. p. 147, 149.

at that date, neither, in its character, extent and faunal contents, has been fully exploited till lately, nor has the interesting fact been sufficiently emphasized that both carry comparatively profuse faunas fundamentally unlike each other but evidently derived from the same direction, and quite unlike the normal fauna of bituminous shales.

STRATIGRAPHY OF THE AGONIATITE LIMESTONE

Madison and Onondaga counties

For the most part the outcrops of this rock in Madison and Onondaga counties are obscured by the soil mantle or, where seen in drainage sections, are of partial thickness and fail to disclose the actual relation of the beds to the involving shales[1].

There are several such small outcrops in the vicinity of Manlius. For example, the rock appears on the road from Eagle village to Chittenango not far from a schoolhouse at which a road turns north, about ½ mile west of the west line of Madison county; and again about ¼ of a mile southwest of Eagle village in a small ravine. In another little ravine near the schoolhouse in district 8, southwest corner of the town of Manlius and about 1½ miles west of the village on the road to Jamesville, the limestone forms the sill of a cascade, being in two layers, the upper about 1 foot thick and the lower nearly 2 feet. So great a thickness is rarely shown by the formation. The rock is hard and compact, specially at its contact above and below with the shales, and the characteristic large cephalopods (Agoniatites expansus, Orthoceras marcellense, etc.) of the formation are mainly in the lower part of the upper layer. About 100 rods farther west another small brook crosses the Jamesville road just at the intersection of a north and south road. Here the Onondaga limestone is considerably flexed, and over it lies a slight exposure in the bed of the creek and on the south bank. None of these exposures has afforded opportunity for an accurate measurement of the thickness of the Marcellus shales above and below the limestone.

[1] The sections in this region and in Cayuga and Ontario courties have at my request recently been reviewed by D. D. Luther, who has supplied much of the detail here given.

About ¾ of a mile southeast of Marcellus village is Dunk's hill, a knoll 40 or 50 feet high. The Agoniatite limestone appears here in a grade cutting on the west side of the hill and again in a field on the south side, and over a considerable area it is covered by only a thin layer of soil. Its thickness is 2 feet 6 inches in two layers. In the immediate vicinity of this locality are other outcrops which the searcher for the interesting fossils of the limestone would do well to exploit. It may be noted however, that frequently the rock is too deeply seamed and etched by weathering to justify the labor, often great, of attempting to collect from it. It is not only of impure character, but the purer calcareous matter is arranged in spots and patches in such a way as to afford least resistance to decomposing agencies. This is notably the nature of the rock in the exposures in Dunk's hill. Another small outcrop occurs in the side of the road about a mile farther toward Cedarvale and again across the valley toward the southwest, where the rock is very compact and lies close to the surface over a large area.

Slate hill is situated about ¾ of a mile southeast of Marcellus village, having the valley of Nine-mile creek on the west. It is composed of black and dark blue shales and shows on the north side along the road at its base a slight exposure of the Agoniatite limestone, and the dark calcareous shales beneath are exposed for a thickness of about 3 feet, on the south side of a neighboring depression. On the dugway road up the hill, black fetid shales are exposed to a thickness of about 20 feet, and above them on the west slope of the hill the upper blue black shales are shown. We shall observe in more westward sections that the horizon of the Stafford limestone is approximately at the junction of these bituminous beds with the blue black shales above.

Other outcrops occur about ½ mile east of St John's school, Manlius, and on the east and west sides of Onondaga Valley. On the west side near Dorwin's spring the rock is 130 feet lower

in actual elevation than at Jamesville and Manlius, a result of the low monocline traversing this region.[1]

About 3 miles west of Marcellus on the road to Mottville, town of Skaneateles, the Agoniatite limestone is very near the surface, but makes few if any well defined outcrops. Although the actual interval between the Onondaga and Agoniatite limestones is not afforded by any of the Onondaga county sections here observed we estimate it to be not far from 20 feet.

Cayuga county

One mile south of the village of Union Springs, and on the east side of the road leading to Levanna, is an abandoned quarry known as " Wood's old quarry ". It is situated in the summit of a flat-topped anticline, the strippings extending pretty well down the sides. The cap rock in the quarry wall is the Agoniatite limestone, 22 to 24 inches thick and in its usual condition, very hard when fresh and dark, almost black in color, varying much in texture and purity and crumbling under the weather. It also contains a good deal of pyrite, which gives old blocks a rusty color. For these reasons it is of little use to the quarrymen and is stripped to reach the Onondaga limestone beneath. At the south end of this a slight thickness of black shales is seen above the limestone. Below, the succession to the Onondaga limestone is as follows: black shales with thin slabs of impure limestone, 3 feet; black shales and thin impure limestones in about equal proportion, 8 feet; impure limestone, 1 foot, 6 inches, with a shaly parting separating it from another layer of like character, 1 foot, underlain by 5 inches of soft black shale which rests on the Onondaga (35 to 40 feet thick) a total for the interval of about 14 feet. The argillaceous and impure limestones constituting the basal parts of these Marcellus strata are largely devoid of fossils, except Styliolina and plant spores, and the Agoniatite limestone itself is less abundant in its large cephalopods than in more eastern outcrops.

1 Prin. J. D. Wilson read a brief account of the stratigraphy and fauna of this limestone in Onondaga county before the Onondaga academy of science, Mar. 25, 1901, and has kindly allowed me to make reference to the facts given in the above paragraph.

This limestone again appears in a small brook, ¼ of a mile south of Wood's quarry. In the outcrops along Criss creek, 2½ miles south of Union Springs, the strata above the horizon of the Agoniatite limestone are shown, and a point of interest in this section is the presence of a bed of 15 feet of blue and olive calcareous shales, lying above the general mass of darker shales, which carries certain trilobites (Homalonotus, Phacops), brachiopods, gastropods, etc. pertaining to the normal Hamilton shale fauna. These shales lie at about the proper horizon of the Stafford limestone, though no trace of this rock has been seen so far east.

Ontario county

The westernmost observed exposure of the Agoniatite limestone occurs on Flint creek, near the village of Phelps. The Lehigh Valley railroad crosses this creek and the Sodus Bay railroad by one bridge. On the south side of this bridge to the southernmost outcrop of Onondaga limestone and 50 rods south of the next highway bridge over the creek, there is a low ledge of the Agoniatite limestone in the bed of the stream. It is here in the usual condition and about a foot thick, underlain by dark impure and bituminous limestones of the same character as those observed at Union Springs but of considerably less thickness. The rock here contains Agoniatites expansus though poorly preserved, lying close above the Onondaga. Though the interval thence to the Onondaga limestone is not exposed it is evidently not in excess of 10 feet.

Genesee county

The collections of the state museum contain a specimen of Agoniatites expansus in a slab of the thin limestones which lie near the top of the Onondaga beds at Lime Rock. This specimen is an individual of large size though of poor preservation.

Erie county

The Lackawanna iron and steel co. has recently sunk shafts and constructed a waterworks tunnel at Stony Point on Lake Erie,

near the south line of Buffalo in the town of West Seneca. These shafts penetrate the rock to a depth of 64 feet and transect a soil covering of 26 feet. Of this rock section 19.6 feet are the black highly bituminous shales of the lower part of the Marcellus and beneath are 9.6 feet referred to the gray Onondaga limestone. Parts of the black shale are somewhat calcareous and bear the peculiar fauna at the base of the Marcellus section of the Livonia salt shaft, referred to more fully on a subsequent page. In the limestone beneath Agoniatites expansus has been found, associated with some small brachiopods which accompany it in its occurence at Cherry Valley.[1]

From the data given above we conclude that in the region west of Madison county to its extinction in Ontario county the Agoniatite limestone continuously approximates to the horizon of the Onondaga limestone and that still farther westward its horizon (the limestone itself having disappeared) actually coincides with and merges into that of the Onondaga limestone.

We now observe the following facts in its passage to its eastward extinction.

Otsego county[2]

Cox's ravine, which begins $\frac{3}{4}$ of a mile northwest of Cherry Valley, shows the following section at base.[3]

	Feet	Inches
1 Black fissile Marcellus shale with the usual fossils.	7	11
Covered	7	4
2 Heavy, black shale with Lunulicardium marcellense	2	8
Covered	7	10
3 Heavy, black shale with large concretions	6	5
4 Limestone at	32	2

[1] Prof. I. P. Bishop directed my attention to these excavations in October of this year and has very kindly given me the rock section there exposed. Richard F. Morgan has at my suggestion made a collection of the organisms there thrown out. I am under obligations to both of these gentlemen.

[2] Dr Ruedemann has recently supplemented the data in our possession bearing on these sections by a careful review of those in Otsego and Schoharie counties considered here.

[3] The top of the Onondaga limestone is not clearly exposed in this section. Levels made from exposures ½ mile north of the railroad station indicate that this first outcrop of Marcellus shales does not lie more than 7 to 10 feet above that limestone.

	Feet	Inches
above base of section and about 40 feet above top of Onondaga. Here begins a series of limestones separated by shale beds and recurring with some differences in the character of the contained fauna. At the base of this lowest limestone, which has here a thickness of......	1	5
occurs abundantly in a nodular layer the goniatite Anarcestes plebeiformis Hall, the only locality recorded for this interesting species, associated with Loxonema minuscula Hall, also known from no other locality. Agoniatites expansus does not occur in this layer, but is occasionally found in an imperfect condition with the rare variety, nodiferus (not elsewhere known) in the shale mass above which is....................	4	9
Then follows another limestone with Agoniatites and a few other fossils......................		8
Barren fissile shale...........................		4
Limestone, top of falls........................		6
Shale with concretions........................	1	4
Gray nodular limestone with small Ambocoelia..	1	4
Dark limestone with ostracodes and Orthoceras separated from above by thin shale bed......	7	2
From this point the section is covered for a distance of ½ mile, representing an elevation of..	67	
Then follow black, typical Marcellus shales (on the Steenburg farm)	10	10
Dark gray limestone, barren in the lower layers with Agoniatites in the middle part and Orthoceras and ostracodes, etc. in the upper part...	7	6
	134	10

The amount of shale overlying these limestones is not shown in these sections. Holes dug for telephone poles along the road to Springfield show black shales at elevations of 40 to 60 feet above the highest outcrop already noted; and near the top of a hill to the east of a road just above the first highway crossing, 60 to 80 feet still higher, are dark gray, weathered, fissile, barren shales. These occurrences indicate at least 100 feet of shale above the recorded section. The repetition of Agoniatites expansus in beds separated by an interval of about 90 feet suggests the probability of a displacement along the covered interval of 67 feet. This point is not yet satisfactorily determined. Assuming its presence we find the Agoniatites fauna at something over 40 feet above the summit of the Onondaga.

If, however, no such displacement exists, the fauna with Agoniatites reappears after an absence from the sediments represented by a deposition of about 90 feet of shales and it thus rises to an elevation of 130 feet above the Onondaga limestone.

Schoharie county

Most of the Agoniatite limestone specimens from Schoharie county in the state collections were obtained by the late John Gebhard jr, probably from localities on the Lamoreaux farm, 1 mile southwest of Schoharie village, and the Burton farm 1 mile still farther south. At these places the limestone lies just below the surface and has been taken out for the construction of farm walls, but no exposure is afforded which defines the position of the beds in the rock section.

On Stony creek, east of Schoharie village, an outcrop of limestone is shown about 50 yards above the bridge near the confluence of the two branches. Here are about 20 inches of dark gray, impure limestone with Orthoceras marcellense and other fossils which usually accompany Agoniatites expansus, though that species has not been observed. For 16 feet above this the section is covered, then follows a continuous exposure of Marcellus shale for nearly a

mile, to Borst's sawmill, which is 180 feet above the limestone. The upper beds in this section, though retaining their dark blue-gray or blackish color, carry Spirifer and Chonetes and in this respect suggest correspondence with the upper beds in western sections which have latterly been regarded as pertaining to the Marcellus.

Typical Hamilton sandy shales are exposed just above Borst's mill. No limestone beds were observed in the section above the basal limestone. The distance of the latter above the Onondaga limestone is approximately estimated from levels, to be from 10 to 30 feet. The evidence in this section clearly indicates the rapid extinction of the Agoniatites limestone eastward from Otsego county and at points east of that here mentioned no outcrops of the horizon or evidence of its index fossils have been recorded.

FAUNA OF THE AGONIATITES LIMESTONE

Most of the species of this horizon have been made known by Conrad and Hall, and the limestone often retains its organic remains in fine preservation. Specially superior and well known are the great shells of Agoniatites expansus Vanuxem (= Gon. vanuxemi Hall). To this is to be added a large number (in view of the total faunal list) of other cephalopods. The fauna is peculiar in that it represents a deep water association introduced briefly in the shallower sea depositing the black shales, and its species are, further, to a notable percentage confined to it. Some of the outcrops of this layer in Onondaga county have of late years been carefully exploited by Prin. John D. Wilson of Syracuse, whose investigations have resulted in several additions to the faunal list, and to whom I am indebted for many favors in the study of the species.

Mesothyra ? (Manlius)
Proetus haldemani *Hall* (Cherry Valley)
Cyrtoceras alternatum *Hall* (Schoharie)
C. liratum *Conrad* (Manlius)
Gomphoceras conradi *Hall* (Schoharie, Manlius)
G. fischeri *Hall* (Manlius)

G. oviforme *Hall* (Schoharie, Manlius)

G. solidum *Hall* (Manlius)

G. transversum *Hall*

Nephriticeras bucinum *Hall* (Manlius)

Nautilus liratus *Hall* (Manlius)

Discites marcellensis *Vanuxem* (Manlius)

Parodiceras discoideum *Conrad* (Manlius, Schoharie)

Agoniatites expansus *Vanuxem* (Schoharie, Cherry Valley, Manlius, Union Springs, Flint creek, Stony Point, Lime Rock (in Onondaga limestone))

Thoracoceras wilsoni *sp. nov.* (Manlius)

Orthoceras aptum *Hall* (Manlius)

O. fustis *Hall* (Manlius)

O. marcellense *Vanuxem* (Manlius)

O. constrictum *Conrad* (Manlius)

Bactrites *sp.*?

Pleurotomaria rugulata *Hall*

Euomphalus planodiscus *Hall* (Manlius)

Loxonema delphicola *Hall* (Manlius)

Macrochilina onondagaensis *sp. nov.* (Manlius)

Chaenocardiola curta *Hall* (Manlius)

Panenka ventricosa *Hall* (Manlius)

Liorhynchus limitare *Hall* (Manlius)

Ambocoelia *cf.* nana *Grabau* (Cherry Valley)

Agoniatites expansus. This species, the diagnostic form of this horizon, is more generally diffused geographically than any of the others. At the west it occurs freely at Wood's quarry south of Union Springs, where the horizon lies close upon the Onondaga limestone. Still farther west, as this horizon approaches more and more nearly the Onondaga limestone, traces of it are less often seen, and west of the Flint creek section, Ontario county, the shell has been observed only at the base of the Marcellus section at Stony Point, Lake Erie. From outcrops of the Onondaga limestone in the neighborhood of Leroy we have a specimen, incomplete but doubtless representing a large individual of this species.

Thoracoceras wilsoni *sp. nov.* Pl. 8, fig. 1–5. The discovery of the species herewith presented is of more than ordinary interest, not alone from the fact that it constitutes a new element in this fauna, but also because of its very close relationship to a form described by Whiteaves from the zone with Stringocephalus burtini in the Devonic rocks of Manitoba.[1] The associates of this fossil in its occurrence at lakes Manitoba and Winnepegosis as reported by Dr Whiteaves are, besides Stringocephalus, some forms which pertain to the middle Devonic as developed in New York, such as Cyrtina hamiltonensis, Atrypa reticularis and var. aspera, Actinopteria boydi, Paracyclas elliptica, also Pentamerus comis Owen, which is not known to be a New York fossil, but pertains to the upper Devonic horizon in the state of Iowa, and a species identified as Rhynchonella pugnus Martin, a form already well known from the upper Devonic of New York, specially in the Chemung fauna at High point, Naples. So far as the peculiar generic characters of this species of Thoracoceras are concerned, they have not heretofore presented themselves in the cephalopod faunas of this state. Nor does the association of this species with the fossils of the Agoniatite limestone justify the construction of the fauna of the latter as in any way indicating the proper geologic horizon of Stringocephalus in the New York sediments.

The shell has a slight cyrtoceran curvature, notable chiefly in the distal or apertural region. The cast of the interior shows a very decided prismatic appearance, there being 10 well defined prism faces with flat or at times slightly concave surfaces. Of these faces that on the inner curvature of the dorsal surface is the broadest and is well defined over the body chamber, where the other faces become faint or quite extinguished. The body chamber shows a slight constriction at about one half its length. In two of the casts in which the body whorl and aperture are

---

1 Descriptions of some new or previously unknown species of fossils from the Devonian rocks of Manitoba. Royal soc. Can. Trans. 1890. § 4, p. 93 (100-10) pl. 4-10 (7, fig. 1-4).

entirely preserved, this chamber has a length of 45 mm, which is equal to the depth of 6.5 chambers.

On the exterior the surface is ornamented by fine concentric or horizontal imbricating or engraved lines, which are bunched together into low concentric annuli and are crossed vertically by ridges of about the same size. These are 10 in number, to correspond with the prism angles. Where these cross the annuli, they are raised into projections which appear for the most part to be short, stout and blunt but in some vertical sections of the shell are apparently extended, acute and spiniform. These exterior markings become fainter on the body whorl, but are plainly visible to the aperture, in this respect contrasting to the condition of the internal surface. The aperture is sinuous with a marked channel on the left lateral margin.

Dimensions. The specimens observed have an apertural diameter of 30 to 40 mm and bear 16 septa in a distance of 100 mm from the last downward. The approximate entire length of these shells was 250 mm.

Locality. Manlius; John D. Wilson, collector and donor.

Macrochilina onondagaensis *sp. nov.* Shell rotund with short acuminate spire having incurved slopes, its length being about $\frac{1}{4}$ the entire length of the shell, or $_3$ that of the body whorl. Whorls largely concealed. Surface convex, sutures impressed; body whorl very high, somewhat abruptly convex near the suture where the surface of the penultimate whorl is overlapped for $\frac{4}{5}$ of its width. Non-umbilicate but with the columellar lip well defined and slightly twisted; aperture entire, outer lip but slightly thickened.

Fig. 1 Macrochilina onondagaensis natural size. Agoniatite limestone, Manlius N. Y.

Surface smooth, shining, bearing only fine concentric lines. Internal cast smooth.

Dimensions. Hight 22 mm; width across body whorl 17 mm; hight of body whorl 18 mm.

Locality. Agoniatite limestone, Manlius.

This very pretty species has been found by Prin. J. D. Wilson of Syracuse, who has considerately presented the type specimen to the state museum. It is unlike any species known from the New York Devonic in its short, concave spire and very large body whorl, features which will also distinguish it from other forms of the genus.

STRATIGRAPHY OF THE STAFFORD LIMESTONE

This limestone has highly characteristic lithologic structure. It is when fresh of a dark chocolate brown, compact in texture and inclined to be splintery under the hammer. Its fossils, in which it for the most part abounds, are often replaced by a black crystalline calcite, and, when weathered, blocks of the rock become gray, while the fossils are contrasted therewith by their dark tint. From the meridian of Flint creek westward to Lake Erie such blocks are common in the drift piles and are at once recognizable.

Along Flint creek is the first appearance of this interesting limestone, but it is seldom that complete sections of the beds are exposed anywhere in western New York. One was afforded by the Livonia salt shaft, and another, fully described at the conclusion of this paper, occurs at Lancaster, Erie co.

In the Livonia salt shaft, as recorded by D. D. Luther and the writer in the 13th report of the state geologist, the Marcellus strata were regarded as beginning at a depth of 650 feet from the surface and continuing downward to a depth of 866.5 feet, giving the beds a thickness of 216.5 feet. This apparently great thickness is due to the fact that, in the succession of the upper beds which pass gradually into the Hamilton shales above, a considerable part of the blue black shales was assigned to this formation on account of the preponderance of Marcellus species. This

portion of the section however simply serves to emphasize the gradual passage of the bituminous shale fauna into that of the calcareous shales and to establish the proper conception of the typical Marcellus fauna as that of these black shale beds and bands.

The Stafford limestone in this section lies at 823 feet, or 173 feet below the assumed top of the formation, the overlying strata being shales. It is here 2 feet thick, and is immediately underlain by 4 feet of black and bituminous shales with Liorhynchus, Panenka, C h o n e t e s m u c r o n a t u s, etc. the usual species of the typical shale beds. Thereunder follow 22 feet of black shales without fossils, this mass underlain by a thin shale bed with the usual species. From here are 13 feet to the top of the Onondaga limestone. Its position is thus about 50 feet above the Onondaga. The section is complete and brings out lucidly the thickening of the lower beds by calcification in their westward extent.

The Stafford limestone appears at various spots across the western district in the depression lying back and south of the Onondaga limestone escarpment. It is to be seen near Baggerly Corners, Ontario co. on the Phelps-Hopewell line road. At Littleville, 2 miles south of Avon, Genesee co. it appears in a gorge behind the mill with dark shales above and below. About a mile south of the station in Avon, in a brook east of the Erie railroad tracks, is another exposure, and the rock is again seen a short distance down the stream and beneath a mass of dark shale, another limestone outcrops, which appears to be the equivalent of the lower bed lying at 854 feet in the Livonia shaft, which we have suggested as marking the probable horizon of the Agoniatite limestone in this western region. Here it rests directly on the Onondaga limestone and stratigraphically is inseparable therefrom. The exposure of Stafford limestone at Stafford, Genesee co. lies about ½ mile southeast of the station, where it has been quarried at various times. Such a large amount of the material lies exposed here that it makes an admirable spot for the collection of its fossils. At Leroy there is an

excellent exposure in the east bank of Oatka creek below the bridge at Main street.

At Lancaster, Erie co. the beds beneath the typical dark limestones at Stafford have become highly calcareous, giving a thickness of upward of 8 feet of the limestone section, all of these beds carrying a Hamilton fauna with some variations in character for the different beds. This section has been carefully studied by Elvira Wood, whose succinct account of the fauna and its variations is given at the close of this article. Here the beds, evidently continuous with the heavy limestones at Stafford, are the uppermost of the section (Miss Wood's vii and viii), and it is inferentially probable that at Stafford, which is only a few miles east of Lancaster, the lower part of this series is concealed; at the same time it is quite evident from the other sections cited that the calcifying of the lower beds is a feature of the western extension of this formation. Between Lancaster and Lake Erie, however, but a few incomplete outcrops of the horizon have been recorded.

FAUNA OF THE STAFFORD LIMESTONE

From the determinations made by the writer some years ago,[1] combined with those given by Miss Wood in the appended paper, we may ascribe the following to the fauna of the Stafford limestone.

1 **Fauna of the Stafford limestone at Stafford, Livonia shaft, Flint creek, Lancaster (Miss Wood's upper beds vii and viii) and elsewhere**

Fishes

Undetermined plates and scales

Worms

Spirorbis

Crustaceans

Homalonotus dekayi *Green*
Phacops rana *Green*
Cryphaeus boothi *Green*
C. boothi *var.* calliteles *Green*

[1] N. Y. state geol. 8th an. rep't p. 60, 1889.

Proëtus macrocephalus *Hall*
Cyphaspis craspedota *Hall & Clarke*
Primitiopsis punctulifera *Hall*

Cephalopods

Nautilus liratus *Hall*
N. *cf.* magister
Nephriticeras bucinum *Hall*
Orthoceras subulatum *Hall*
O. aegea *Hall*
O. marcellense *Vanuxem*
O. fenestrulatum *Clarke*
O. staffordense *Clarke*
O. eriense *Hall*

Pteropods

Tentaculites gracilistriatus *Hall*
Styliolina fissurella *Hall*

Gastropods

Platyceras attenuatum *Hall*
P. bucculentum *Hall*
Cyrtolites mitella *Hall*
Bellerophon lyra *Hall*
Diaphorostoma lineatum *Conrad*
Pleurotomaria lucina *Hall*
P. rugulata *Hall*
P. itys *Hall*
P. capillaria *Conrad*
P. sulcomarginata *Conrad*
Loxonema hamiltoniae *Hall*
Onychochilus nitidulus *Clarke*

Lamellibranchs

Pterinopecten exfoliatus *Hall*
Actinopteria muricata *Hall*
Liopteria laevis *Hall*
Cypricardinia indenta *Conrad*

Panenka mollis *var.* costata *Hall*
P. radians *Conrad*
Pterochaenia fragilis *Hall*

Brachiopods

Terebratula lincklaeni *Hall*
Cryptonella planirostris *Hall*
C. rectirostris *Hall*
Camarotoechia sappho *Hall*
C. horsfordi *Hall*
C. dotis *Hall*
C. prolifica *Hall*
C. pauciplicata *Wood*
Spirifer audaculus *Conrad*
S. fimbriatus *Conrad*
S. subumbona *Hall*
Ambocoelia nana *Grabau*
Meristella barrisi *Hall*
Trematospira gibbosa *Hall*
Strophalosia truncata *Hall*
Productella spinulicosta *Hall*
P. shumardiana *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
C. lepidus *Hall*
Tropidoleptus carinatus *Conrad*
Stropheodonta inaequistriata *Conrad*
Leptostrophia perplana *Conrad*
Orthothetes chemungensis *Conrad*
O. arctostriatus *Hall*
Rhipidomella vanuxemi *Hall*
R. cyclas *Hall*
Crania crenistriata *Hall*
C. recta *Wood*
Craniella hamiltoniae *Hall*

Bryozoans

Hederella canadensis *Nicholson*
H. cirrhosa *Hall*
Reptaria stolonifera *Rolle*

Blastoids

Nucleocrinus lucina *Hall*

Corals

Favosites placenta *Hall*
Stereolasma rectum *Hall*
Striatopora limbata *Conrad*
Romingeria
Aulopora

2 Fauna of lower beds at Lancaster (Miss Wood's i-vi)

Worms

Spirorbis

Crustaceans

Cryphaeus boothi *Green*
Phacops rana *Green*
Cyphaspis craspedota *Hall*
Primitiopsis punctulifera *Hall*

Cephalopods

Orthoceras exile *Hall*
O. marcellense *Vanuxem*
Bactrites

Gastropods

Platyceras attenuatum *Hall*
Pleurotomaria capillaria *var.* rustica *Hall*
Onychochilus nitidulus *Clarke* (?)
Loxonema

Lamellibranchs

Pterinopecten exfoliatus *Hall*
Actinopteria muricata *Hall*
Cypricardinia indenta *Conrad*

Palaeoneilo
Panenka lincklaeni *Hall*
Leptodesma marcellense *Hall*

Brachiopods

Meristella barrisi *Hall*
M. meta *Hall*
Nucleospira concinna *Hall*
Spirifer mucronatus *Conrad*
S. fimbriatus *Conrad*
S. subumbona *Hall*
Tropidoleptus carinatus *Conrad*
Ambocoelia nana *Grabau*
Productella dumosa *Hall*
P. spinulicosta *Hall*
Strophalosia truncata *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
Liorhynchus limitare *Hall*
Camarotoechia sappho *Hall*
C. prolifica? *Hall*
Schizobolus truncatus *Vanuxem*

Bryozoans

Hederella cirrhosa *Hall*
Trematopora tortalinea *Hall*

Pteropods

Tentaculites gracilistriatus *Hall*

Corals

Favosites placenta *Hall*
Ceratopora jacksoni *Grabau*
C. dichotoma *Grabau*

The fauna of the Stafford limestone is essentially an outburst of typical Hamilton species with a few survivors of earlier type, and invaded the state from the west, penetrating eastward as

far as Ontario county in a pure limestone sediment and perhaps as far as Cayuga county with a more argillaceous sediment, and was then driven back by the shallowing sea and the return of the bituminous muds. Its western origin determines the same derivation for the fauna of the great mass of calcareous and sandy Hamilton shales, which held the field for a long period over the full width of the state, but was eventually driven out of western New York by the invasion of a new western fauna, heralded by the early intrusion of the worldwide brachiopod, Hypothyris cuboides, and immediately followed by the outpouring of species constituting the fauna of the Manticoceras intumescens zone (Portage stage).

OTHER LIMESTONE BEDS IN THE MARCELLUS SHALES AND THEIR FAUNAS

A noteworthy limestone layer has been recorded in the Livonia shaft section lying 27 feet below the Stafford limestone, the interval being filled with black shales. This layer is 4 feet thick, the upper 2 feet being impure and almost devoid of fossils, the lower being a quite pure limestone containing the following species:

Phacops rana *Green*
Orthoceras subulatum *Hall*
O. incarceratum *Clarke*
O. lima *Hall*
Tornoceras uniangulare *Conrad*
Tentaculites gracilistriatus *Hall*
Pleurotomaria lucina *Hall*
Aviculopecten *cf.* fasciculatus *Hall*
Modiomorpha subalata
M. concentrica *Hall*
Cypricardinia indenta *Conrad*
Microdon bellistriatus *Conrad*
Nuculites oblongatus *Conrad*
Palaeoneilo plana *Conrad*
Tropidoleptus carinatus *Conrad*
Spirifer audaculus *Conrad*
Ambocoelia umbonata *Conrad*

A. praeumbona *Hall*
Athyris spiriferoides *Eaton*
Coelospira camilla *Hall*
Terebratula *sp.*
Stropheodonta inaequistriata *Conrad*
Leptostrophia perplana *Conrad*
Orthothetes pandora *Hall*
O. bellulus *Clarke*
Orthis *cf.* lenticularis *Hall*
Chonetes deflectus *Hall*
Chonetes *cf.* yandellanus *Hall*
Pholidops hamiltoniae *Hall*
Stictopora incisurata *Hall*
Stereolasma rectum *Hall*

Just below this lies a foot of impure limestone like that immediately above, composed largely of Tentaculites gracilistriatus with

Tornoceras uniangulare *Conrad*
Chonetes lineatus *Hall*
C. *cf.* deflectus *Hall*
Liorhynchus limitare *Hall*

From here downward for 6 feet are black shales with irregular concretions, underlain by 2 feet of hard, black calcareous shale with

Styliolina fissurella *Hall*
Liorhynchus limitare *Hall*
Panenka, *very large, cf.* P. lincklaeni *Hall*

A few inches below comes in normal Onondaga limestone. The fauna of this locally developed limestone bed carries certain surviving evidences of the Onondaga sea, in the species Coelospira camilla, Chonetes cf. yandellanus and Orthis cf. lenticularis; also in the Chonetes lineatus of the basal bed. The same horizon with more shaly sediment was exposed in the recent excavation at Stony Point, Lake Erie, referred to above, where, in addition to many of the

characteristic species (Orthothetes bellulus, Chonetes cf. yandellanus, Ambocoelia praeumbona) a single well defined example of Agoniatites expansus was obtained. It constitutes the first manifestation in New York state sections of the Hamilton fauna in its prenuncial invasion from the west, when it was complicated with the fauna already on the ground and failed to gain a lasting foothold or to develop favorably. The Agoniatites expansus occurring here may, in view of the other evidence, properly be regarded, like the species last mentioned, as a survivor of the Onondaga fauna.

CONCLUSION

The Agoniatite limestone fauna was an invader from the west, dating from the closing phase of the Onondaga limestone. Directly in its train followed the prenuncial cohorts of the Hamilton fauna. The former held the footing it had gained while the latter yielded to unfavorable conditions and temporarily retired from the field.

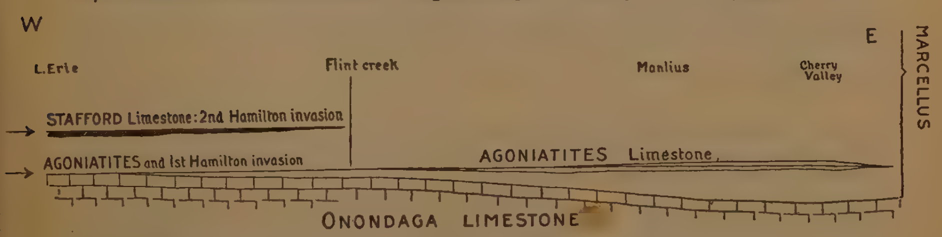


Fig. 2 Diagrammatic representation of the relation of the Hamilton faunal invasions to the sediments of Onondaga and Marcellus time.

The facts recorded above indicate quite clearly the descent of the Agoniatite horizon westward from an elevation of fully 50 feet above the summit of the Onondaga limestone to and probably into that limestone itself, a condition which stratigraphy interprets as a replacement in central and eastern New York sections, of the upper layers of the latter by the lower beds of the Marcellus shales or, conversely, the occupancy of the field in western New York by the Onondaga sea after Marcellus deposition had for some time been under way in central and eastern New York. The fauna attained its highest development in Onondaga and eastward counties where it reached a secluded

part of the interior sea most favorable for its increase. Here it is followed and preceded by a quite distinct association involved in bituminous muds, and it is therefore natural that a few of the Marcellus species have strayed into the Agoniatite fauna. The tendency to lime deposition recurred during Marcellus time after the sea had shallowed in western New York, but ere that event the Agoniatite derivative of the Onondaga fauna had migrated eastward and disappeared.

The fauna of the Stafford limestone was also an invader of later date from the west and the second appearance of the Hamilton fauna within the confines of this state.

The composition of the species list is final in determining the affiliation of the Stafford fauna. This invasion, too, was unsuccessful, reaching no farther eastward than the eastern part of Ontario county. Had the fauna dispersed more widely and been able to take and keep possession of the ground which it subsequently acquired, Hamilton time and sedimentation would have been a more important element in the New York succession.

MARCELLUS (STAFFORD) LIMESTONES OF LANCASTER, ERIE CO. N. Y.

(Communicated for the report of the state paleontologist)

BY ELVIRA WOOD

Pl. 9

INTRODUCTION

The existence of a bed of limestone within the Marcellus formation of western New York was early recorded by Prof. James Hall[1]; and to this limestone John M. Clarke[2] has given the name Stafford limestone, because of its exceptional development at Stafford, Genesee co.

Prof. I. P. Bishop[3] describes the occurrence of limestone beds at Lancaster, Erie county which he correlates with the Stafford limestone of Clarke, but with a mention of only one fossil, an Orthoceras, in the upper beds. No account of the fossils of this locality has been published, and it is with the fauna and its characteristics that the following paper is chiefly concerned.

SUCCESSION OF THE MARCELLUS BEDS AT LANCASTER

The Marcellus limestones of Lancaster N. Y. are best exposed in the bed of Plumbottom creek above its junction with Cayuga creek. The general direction of these streams is shown in the accompanying map of a part of the town of Lancaster.

The dark gray Marcellus shales are first seen in the bed of Plumbottom creek about half way between Foundry and Court streets. Ascending the stream toward the east the bed rock changes in character to a compact limestone lighter in color than the shale, and highly fossiliferous. The limestone is separable into beds varying in lithologic character and in fossil contents, and is well exposed in the bed and banks of the creek to the dam above Court street, and in the quarry of George

1 Geol. N. Y. 4th geol. district 1843. p. 177-83.

2 List of the species constituting the known fauna and flora of the Marcellus epoch in New York. N. Y. state geol. 8th an. rep't. 1888. p. 60.

3 Structural and economic geology of Erie county. N. Y. state geol. 15th an. rep't. 1898. 1:305.

Bingham above the dam. In this quarry may also be seen the contact between the limestone and the dark Marcellus shale and shaly limestones which form the bed rock beneath the surface soil of the region.

DETAILED DESCRIPTION OF THE SECTION AT PLUMBOTTOM CREEK

The general relation of the limestone beds to those of the Marcellus shale is shown in the following table, where the typical Marcellus layers are lettered, and the limestones numbered, from below upward. The limestone beds have been carefully measured and these measurements have been previously recorded by Bishop[1].

SECTION EXPOSED AT PLUMBOTTOM CREEK

		Inches	Feet	Inches
Shaly limestone	H	18		
Shaly limestone	G	5		
Shale	F	18		
			3	5
Limestone	VIII	12		
	VII	14		
	VI	14		
	V	18		
	IV	10		
	III	14		
	II	6		
	I	12		
			8	4
Lower shale	E	12		
	D	12		
	C	6		
	B	4		
	A	4		
			3	2
			14	11

[1] Structural and economic geology of Erie county. N. Y. state geol. 15th an. rep't. 1898. 1:305.

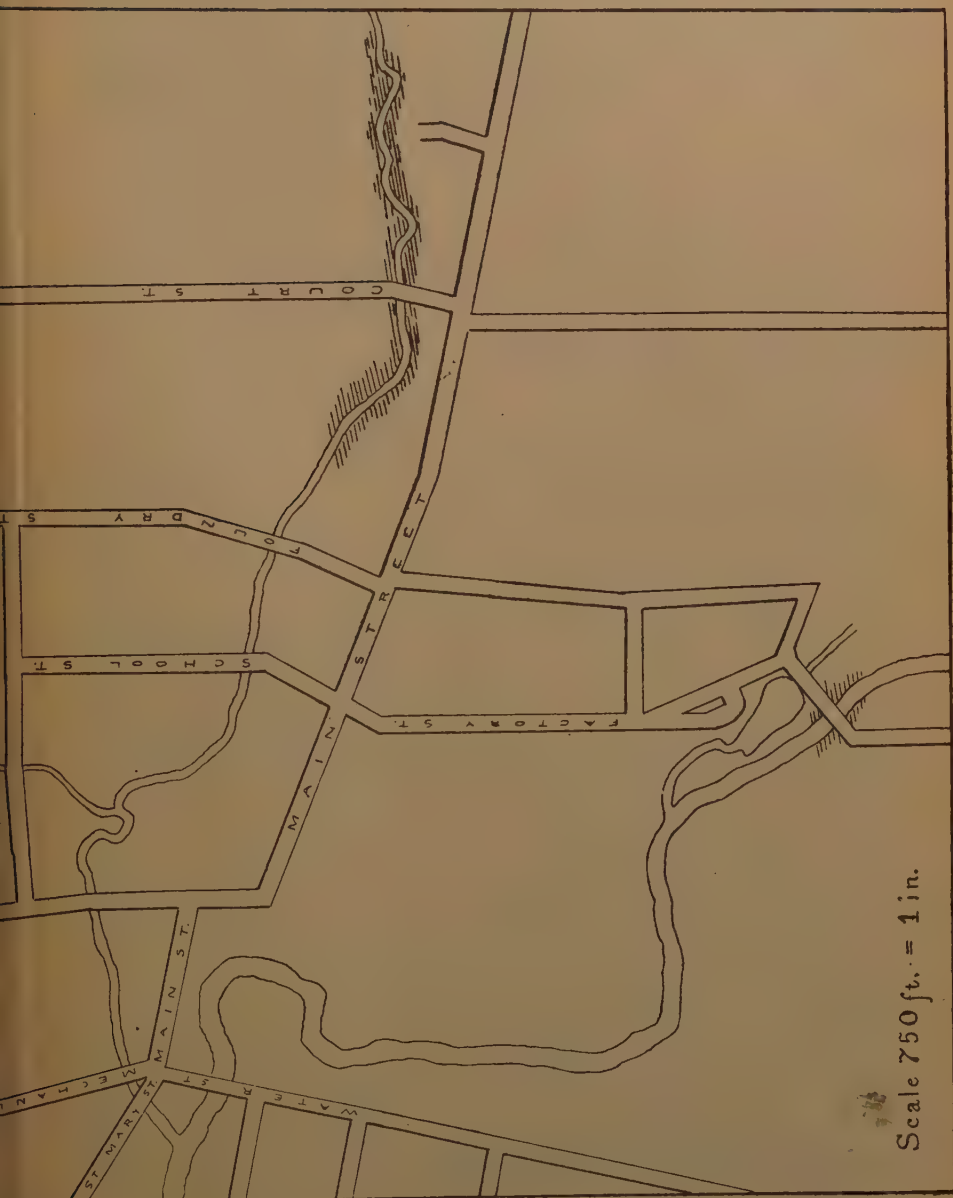


FIG. 1 Sketch map of Plumbottom creek, Lancaster N. Y.

Lower Marcellus shale

A 4 inches. This is the lowest layer of the Marcellus shales exposed in the section. The rock is a gray calcareous shale breaking irregularly, and characterized by the great abundance of ostracodes, certain layers being thickly covered with them. Styliolina fissurella occurs frequently among the ostracodes, but other fossils are comparatively rare. The following species were found in this bed:

Chonetes mucronatus *Hall*	r[1]
Strophalosia truncata (*Hall*)	r
Liorhynchus limitare (*Vanuxem*)	rr
Ambocoelia praeumbona *Hall*	rr
Nuculites nyssa *Hall*	c
Lunulicardium fragile *Hall*	c
Modiomorpha subalata (*Conrad*)	r
Styliolina fissurella (*Hall*)	c
Orthoceras subulatum *Hall*	rr
Isochilina (?) fabacea *Jones*	cc
Primitiopsis punctulifera (*Hall*)	r

B 4 inches. This bed is a gray extremely fissile shale slightly darker in color than bed A. Fossils are abundant, Chonetes mucronatus, Strophalosia truncata, and Lunulicardium fragile being the most common forms, and all about equally numerous. The complete list is as follows:

Chonetes mucronatus *Hall*	cc
Strophalosia truncata (*Hall*)	cc
Liorhynchus limitare (*Vanuxem*)	rr
Tropidoleptus carinatus *Conrad*	rr
Ambocoelia nana *Grabau*	r
Nuculites triqueter *Conrad*	r
Lunulicardium fragile *Hall*	cc
Modiomorpha subalata (*Conrad*)	rr
Styliolina fissurella (*Hall*)	cc
Orthoceras subulatum *Hall*	rr
Goniatites ?	rr
Isochilina (?) fabacea *Jones*	rr

[1] c, common; cc, very common; r, rare; rr, very rare.

C 6 inches. The top of this bed is about 2 feet below the lowest limestone layer. It is a calcareous shale much less fissile than bed B. The rock recalls bed A in general appearance, but is considerably darker and is highly fossiliferous. Nuculites triqueter is the most common fossil.

The following species were found here.

Reptaria stolonifera *Rolle*	rr
Chonetes mucronatus *Hall*	c
Strophalosia truncata (*Hall*)	rr
Liorhynchus limitare (*Vanuxem*)	r
Ambocoelia nana *Grabau*	r
Nuculites nyssa *Hall*	r
N. triqueter *Conrad*	cc
Leptodesma marcellense *Hall*	rr
Lunulicardium fragile *Hall*	c
L. curtum *Hall*	r
Aviculopecten exacutus *Hall*	rr
Modiomorpha subalata (*Conrad*)	r
Pleurotomaria rugulata (?) *Hall*	rr
Styliolina fissurella (*Hall*)	r
Orthoceras subulatum *Hall*	c
Goniatites vanuxemi (?) *Hall*	c
Isochilina (?) fabacea *Jones*	r

D 12 inches. The lower part of bed D is similar to the preceding, but is more fissile and contains Liorhynchus limitare (a rare form in bed C) as the most abundant fossil. The fissility becomes more pronounced till, in the upper part of the bed, the rock breaks into extremely thin laminae with their surfaces crowded with the flattened shells of Liorhynchus limitare and scattered individuals of Strophalosia truncata. In certain of these upper layers the latter condition becomes reversed and the Strophalosia is the more abundant form, the shells overlapping one another. The individuals of both species are here exceptionally large. This layer is not well exposed in the bed of Plumbottom creek but may be seen in situ in places along the bank.

The same layer occurs in the bed of Cayuga creek below the upper carriage bridge, about half a mile southwest from the outcrop in Plumbottom creek. Large slabs of this rock are found on the banks of the stream just below the upper bridge and have been apparently lifted out by frost and ice action, but belong below the exposed limestone which here forms a small fall with a pool 4 or 5 feet deep at its base. The lowest layer of limestone evidently corresponds to bed I (see below). Above this are two layers of limestone, the lower 11 and the upper 7 inches thick and still farther up the stream is a bed which corresponds to bed V of the Plumbottom creek section.

The fossils from the lowest bed, Cayuga creek, are of the same species as those of the following list from Plumbottom creek, with the addition of Panenka lincklaeni.

Chonetes mucronatus *Hall*	r
Strophalosia truncata (*Hall*)	cc
Liorhynchus limitare (*Vanuxem*)	cc
Tropidoleptus carinatus (*Conrad*)	r
Ambocoelia nana *Grabau*	cc
Nuculites nyssa *Hall*	rr
N. triqueter *Conrad*	r
Lunulicardium fragile *Hall*	r
Aviculopecten exacutus *Hall*	rr
Styliolina fissurella (*Hall*)	cc
Orthoceras subulatum *Hall*	rr
Goniatites ?	rr
Isochilina (?) fabacea *Jones*	rr

E 12 inches. The bed which immediately underlies the limestones is a gray calcareous shale abounding in Orthoceras subulatum and Chonetes scitulus. At certain levels of the rock are apparently current accumulations of crowded and broken shells of Lunulicardium fragile. The rock splits irregularly into thin layers.

The fossils found in the bed are as follows:

Chonetes scitulus *Hall*	cc
Ambocoelia nana *Grabau*	rr
Orthonota (?) parvula *Hall*	rr
Nuculites triqueter *Conrad*	rr
Panenka lincklaeni *Hall*	rr
Lunulicardium fragile *Hall*	cc
Styliolina fissurella (*Hall*)	cc
Orthoceras subulatum *Hall*	cc
Cryphaeus boothi *Green*	rr
Primitiopsis punctulifera (*Hall*)	c
Isochilina (?) fabacea *Jones*	c

Marcellus (Stafford) limestone

I 12 inches. The lowest bed of the limestone series presents a striking contrast both in lithologic character and in its fauna to the shale which underlies it. This bed has an irregularly hummocky surface of concretionary origin, though it is practically a continuous mass. The rock is compact, dark gray in color, with no tendency toward shaly structure. It is soft and apparently contains little silicious matter.

The whole bed is largely made up of shells of Strophalosia truncata and Ambocoelia nana, the extreme irregularity of fracture being due to the innumerable fragments of these shells, whose black, shining surfaces give the rock a very dark appearance. As might be expected, in the limestone the individuals are not at all flattened, but they are usually of small size, for each species.

As noted above, this bed also occurs in Cayuga creek, where it forms a fall beneath the upper carriage bridge, and it is exposed in the bed of the stream. It is 12 inches thick and the character of the rock is indistinguishable from that of the same bed at Plumbottom creek. The fossils are of the same species.

In an excavation for a sewer near the corner of Buffum and Seneca streets, in southeastern Buffalo, material from this bed

was brought to the surface, and shows in addition to the fossils mentioned below well preserved specimens of Panenka lincklaeni. For material from this locality I am indebted to Miss I. C. Strickler of Buffalo.

Still another outcrop of this bed has been observed on the left bank of Ellicott creek near Wende station. Orthoceras exile is a common fossil at this place.

The species identified from this bed at Lancaster are:

Chonetes mucronatus *Hall*	cc
Strophalosia truncata (*Hall*)	cc
Liorhynchus limitare (*Vanuxem*)	c
Ambocoelia nana *Grabau*	cc
Meristella meta *Hall*	rr
Orthoceras exile *Hall*	rr

II 6 inches. This bed is made up of large concretions which are confluent or separated by small masses of calcareous shale only. The limestone of which the concretions are composed is similar to that of bed I, but is finer grained and breaks with a conchoidal fracture. Fossils are less numerous than in bed I, there being fewer individuals but many more species. Strophalosia truncata and Ambocoelia nana are slightly larger than the same species in the underlying bed. The list of fossils is as follows:

Chonetes mucronatus *Hall*	c
C. scitulus *Hall*	rr
Strophalosia truncata (*Hall*)	cc
Productella dumosa *Hall*	r
Liorhynchus limitare (*Vanuxem*)	cc
Ambocoelia nana *Grabau*	cc
Spirifer (Martinia) subumbona *Hall*	rr
Palaeoneilo *sp.*	rr
Leptodesma marcellense *Hall*	c
Pleurotomaria itys *Hall*	r
P. capillaria *var.* rustica *Conrad*	r
Onychochilus (?) nitidulus *Clarke*	rr

Loxonema *sp.*	rr
Coleolus tenuicinctus (?) *Hall*	rr
Orthoceras exile *Hall*	r
O. marcellense *Vanuxem*	r
Phacops rana (*Green*)	rr
Primitiopsis punctulifera *Hall*	r

III 14 inches. This bed is a mass of confluent concretions whose surfaces often show cracks filled with consolidated mud. The concretions are of compact, rather light gray limestone, which is harder and breaks more irregularly than that of bed II. Irregular masses of crystallized calcite, probably filling cavities left by dissolved shells, are common, and there are also small masses of sphalerite and chalcopyrite. Fossils are abundant, well preserved, and indicate fairly robust individuals of each species.

The following fossils were found in this bed:

Schizobolus concentricus (*Vanuxem*)	rr
Chonetes mucronatus *Hall*	c
C. scitulus *Hall*	rr
Strophalosia truncata (*Hall*)	r
Liorhynchus limitare (*Vanuxem*)	c
Spirifer (Martinia) subumbona *Hall*	rr
Ambocoelia nana *Grabau*	r
Nucleospira concinna *Hall*	rr
Meristella barrisi *Hall*	rr
Leptodesma marcellense *Hall*	rr
Pleurotomaria itys *Hall*	rr
Onychochilus (?) nitidulus (?) *Clarke*	r
Loxonema *sp.*	r
Coleolus tenuicinctus (?) *Hall*	c
Orthoceras exile *Hall*	c
Phacops rana (*Green*)	c
Primitiopsis punctulifera *Hall*	rr

IV 10 inches. The character of this bed is similar to that of the preceding except that the large flattened concretions which

form the main portion of the mass are of a darker and somewhat harder limestone than that of bed III. Spirifer (Martinia) subumbona, Ambocoelia nana and Strophalosia truncata of large size are common fossils. Ceratopora jacksoni is also common, the long corallites standing out in relief on the weathered surface.

The list of species found is as follows:

Ceratopora jacksoni *Grabau*	cc
Spirorbis *sp.*	r
Hederella cirrhosa *Hall*	rr
Craniella hamiltoniae (*Hall*)	rr
Chonetes mucronatus *Hall*	cc
Strophalosia truncata (*Hall*)	cc
Productella dumosa *Hall*	rr
Camarotoechia prolifica (?) (*Hall*)	c
Liorhynchus limitare (*Vanuxem*)	c
Spirifer (Martinia) subumbona *Hall*	cc
Ambocoelia nana *Grabau*	cc
Cypricardinia indenta (*Conrad*)	r
Pleurotomaria *sp.*	rr
Phacops rana (*Green*)	r

V 18 inches. The proportion of shale at this level is considerably increased. The whole bed is soft and decomposes readily under the action of the weather.

This layer occurs again in the bed of Cayuga creek, where it forms the upper of the limestone layers mentioned above. There the lowest of the limestone layers corresponds with bed I, while this, as indicated by the abundance of Chonetes scitulus in both beds, may be correlated with bed V. At least two intervening beds could be recognized. The lithologic character of the 11 inch bed and the few fossils obtained are in correspondence with bed II at Plumbottom creek and there is a similar correspondence between the 7 inch bed and bed IV, but the small amount of material obtained does not justify a definite correlation. The intervening limestone could not be

accurately measured, and the entire thickness is probably greater than 18 inches, since this corresponds to 30 inches of the Plumbottom creek section, and the beds I and V at Cayuga creek have suffered little if any diminution in thickness. Bed V may be seen below the electric car bridge and just at the foot of the dam which rests on it. At this place the entire thickness of the bed is exposed. It seems to be made up of two layers of concretions embedded in shale, the lower 12, and the upper 6 inches in thickness. The middle part is compact and fossiliferous, the upper and lower parts more shaly and with fewer fossils. Chonetes scitulus is the most common fossil, while Ceratopora jacksoni and C. dichotoma are fairly abundant.

Fragments from a bed similar to this were obtained from the locality previously mentioned, near the corner of Buffum and Seneca streets, Buffalo. They contain Chonetes mucronatus, C. scitulus, Strophalosia truncata, Spirifer mucronatus and Cyphaspis craspedota.

The following list offers a means of comparing fossils from bed V, Plumbottom creek, with those from Cayuga creek.

Plumbottom creek

Crinoid stems	rr
Chonetes mucronatus *Hall*	rr
C. scitulus *Hall*	cc
Strophalosia truncata (*Hall*)	r
Camarotoechia prolifica (?) *Hall*	c
Liorhynchus limitare (*Vanuxem*)	rr
Tropidoleptus carinatus (*Conrad*)	r
Spirifer (Martinia) subumbona (*Hall*)	c
S. mucronatus *Conrad*	r
Ambocoelia nana *Grabau*	c
Leptodesma marcellense *Hall*	rr
Phacops rana (*Green*)	rr
Cryphaeus boothi *Green*	c

Cayuga creek

Fistulipora *sp.*	rr
Stictopora *sp.*	rr
Ceratopora jacksoni *Grabau*	cc
C. dichotoma *Grabau*	c
Crinoid stems	c
Chonetes mucronatus *Hall*	r
C. scitulus *Hall*	cc
Atrypa spinosa *Hall*	rr
Liorhynchus limitare (*Vanuxem*)	rr
Spirifer mucronatus *Conrad*	r
Ambocoelia nana *Grabau*	rr
Phacops rana (*Green*)	r

VI 14 inches. Farther up, near the dam, another layer of impure concretionary limestone is exposed in the bed of the stream. The rock breaks irregularly into relatively thin layers. C y p r i c a r d i n i a i n d e n t a is the most common fossil.

The complete list is as follows:

Favosites placenta *Rominger*	c
Crinoid stems	c
Trematopora (Orthopora) tortalinea *Hall*	r
Chonetes mucronatus *Hall*	r
C. scitulus *Hall*	c
Productella spinulicosta *Hall*	r
Camarotoechia sappho *Hall*	r
Liorhynchus limitare (*Vanuxem*)	r
Spirifer mucronatus *Conrad*	rr
S. (Reticularia) fimbriatus (*Conrad*)	rr
Actinopteria muricata *Hall*	rr
Pterinopecten exfoliatus *Hall*	rr
Cypricardinia indenta *Conrad*	cc
Platyceras (Orthonychia) attenuatum *Hall*	rr
Tentaculites gracilistriatus *Hall*	rr
Phacops rana (*Green*)	r
Cryphaeus boothi *Green*	rr

VII 14 inches. Near the foot of the dam, and just at the bend of the stream, a 14 inch layer of compact semicrystalline limestone is exposed, and above the dam in the quarry the same bed may again be seen. This limestone contains considerable pyrite in minute grains, and also small segregations of flint. It is fine grained, and breaks with a conchoidal fracture. The rock is quarried, the quarrying having proceeded in the fall of 1899 to a depth of 9 inches in the underlying bed, VI. This is the most interesting bed of the section, being rich in large and well preserved fossils of many species. Meristella barrisi is the most abundant fossil, and large Orthocerata are fairly common. The following species were identified.

Stereolasma rectum (*Hall*)	rr
Crinoid stems	r
Spirorbis *sp.*	c
Hederella canadensis (*Nicholson*)	rr
H. cirrhosa (*Hall*)	r
Reptaria stolonifera *Rolle*	r
Crania crenistriata *Hall*	rr
C. recta *sp. nov.*	r
Craniella hamiltoniae (*Hall*)	c
Stropheodonta (Leptostrophia) perplana (*Conrad*)	rr
S. inequistriata (*Conrad*)	cc
Orthothetes chemungensis arctostriata *Hall*	rr
Chonetes mucronatus *Hall*	cc
C. lepidus *Hall*	rr
Productella spinulicosta *Hall*	cc
Rhipidomella vanuxemi *Hall*	r
Camarotoechia horsfordi *Hall*	rr
C. sappho *Hall*	cc
C. pauciplicata *sp. nov.*	rr
Cryptonella rectirostris *Hall*	r
C. planirostris *Hall*	rr
Spirifer (Martinia) subumbona *Hall*	r
S. (Reticularia) fimbriatus (*Conrad*)	c

Ambocoelia nana *Grabau*	r
Trematospira gibbosa *Hall*	r
Meristella barrisi *Hall*	cc
Lunulicardium fragile *Hall*	rr
Actinopteria muricata *Hall*	rr
Pterinopecten exfoliatus *Hall*	r
Pleurotomaria lucina *Hall*	rr
Styliolina fissurella (*Hall*)	c
Orthoceras marcellense *Vanuxem*	c
O. eriense *Hall*	rr
O. aegea *Hall*	rr
Nephriticeras bucinum (*Hall*)	rr
Phacops rana (*Green*)	c
Cryphaeus boothi *Green*	rr
Cyphaspis craspedota *Hall & Clarke*	rr

VIII 12 inches. Near the eastern end of the quarry is exposed another bed of limestone essentially like the last lithologically and containing similar fossils but with fewer individuals. This bed constitutes the upper member of the limestone series, and from its light gray color, compact texture, and its many species of large fossils, it is strongly contrasted with the dark Marcellus shale which overlies it.

The fossils found in this bed are as follows:

Favosites placenta *Rominger*	rr
Stereolasma rectum (*Hall*)	rr
Crinoid stems	r
Spirorbis *sp.*	c
Craniella hamiltoniae (*Hall*)	c
Stropheodonta (Leptostrophia) perplana (*Conrad*)	rr
Orthothetes chemungensis arctostriata *Hall*	rr
Chonetes mucronatus *Hall*	c
Rhipidomella vanuxemi *Hall*	rr
Camarotoechia sappho *Hall*	c
Cryptonella planirostris *Hall*	rr
Ambocoelia nana *Grabau*	rr

Trematospira gibbosa *Hall*	rr
Meristella barrisi *Hall*	cc
Panenka mollis *Hall*	rr
Cypricardinia indenta (*Conrad*)	rr
Styliolina fissurella (*Hall*)	c
Tentaculites gracilistriatus (*Hall*)	rr
Orthoceras marcellense *Vanuxem*	c
O. fenestrulatum *Clarke*	rr
Phacops rana (*Green*)	r
Primitiopsis punctulifera (*Hall*)	r

Marcellus shale

F 18 inches. Overlying the upper limestone bed is a fissile gray shale, some parts of which are heavy bedded. It contains Ambocoelia umbonata and Styliolina fissurella in great abundance, the former standing out in relief on the weathered surfaces. Species identified are:

Ceratopora dichotoma *Grabau*	r
Chonetes lepidus *Hall*	c
Liorhynchus limitare (*Vanuxem*)	r
Atrypa reticularis (*Linné*)	c
Ambocoelia umbonata (*Conrad*)	cc
Meristella barrisi *Hall*	rr
Lunulicardium fragile *Hall*	r
Styliolina fissurella (*Hall*)	cc
Orthoceras aegea *Hall*	c
Phacops rana (*Green*)	cc

G 5 inches. Bed F is followed by a dark gray earthy and somewhat shaly limestone with few fossils except Styliolina fissurella which is abundant. The following were found:

Ceratopora dichotoma *Grabau*	r
Liorhynchus limitare (*Vanuxem*)	c
Styliolina fissurella (*Hall*)	cc

H 18 inches. The upper exposed bed which forms the substratum beneath the soil, is a shaly dark bluish gray limestone.

The only fossils observed were a few fragments, probably plant remains, Liorhynchus limitare and Lunulicardium fragile.

Other exposures of the upper Marcellus shales have been noted on the banks of Cayuga creek. At Lake Como, above the level of the dam, is a 5 foot layer of gray calcareous shale containing Liorhynchus limitare as its most common fossil, and, farther up the creek, at Van Duzee's farm, a 4 foot layer of similar shale is exposed in the bed of the stream. It contains Liorhynchus limitare, Strophalosia truncata, Chonetes lepidus, etc. It thus appears that at this locality also the fauna of the upper shales is typically Marcellus in character and strongly contrasted with that of the limestones below.

REVIEW OF THE FAUNA

ANTHOZOA

STEREOLASMA Simpson

Stereolasma rectum (Hall)

Simpson. N. Y. state mus. Bul. 39, p. 205

Two specimens only of this species were found. The individuals are small and both represent the lower part of the coral. They are well preserved, showing the septa and numerous dissepiments. One specimen measures 13 mm in length, and 9 mm in diameter.

FAVOSITES Lamarck

Favosites placenta Rominger

Geol. sur. Mich. 3: 34, pl. 2

This coral occurs as thin, irregularly undulating expansions in beds VI and VIII. The polished section shows the corallites to be sometimes of equal size but more commonly large and somewhat rounded individuals are surrounded by others which are smaller and more angular.

AULOPORA Goldfuss

Aulopora *sp.*

A loosely branching corallum, probably of this genus, was found attached to Orthoceras eriense. The upper half is broken away showing only a longitudinal section. Budding takes place from the upper part of the corallites, and usually from one side only, but at about every fourth or fifth individual a bud is produced on both sides, thus giving rise to the loose branching, characteristic of the species. This form resembles Aulopora subtenuis of the Helderbergian, but, on account of the imperfect preservation of the fossil, no specific determination has been made.

CERATOPORA Grabau

Ceratopora jacksoni Grabau, pl. 1, fig. 1

Bost. soc. nat. hist. Proc. 28:415, pl. 1, 2

Long branching individuals of this species are very common in bed IV, and they occur also at Cayuga creek. Very perfect specimens are found on the weathered surfaces, and fragments from 1 to 2 inches long may be easily detached from the rock.

Ceratopora dichotoma Grabau

Bost. soc. nat. hist. Proc. 28:418, pl. 2, 3, 4

Only fragments comprising two or three corallites were found. They occur in bed V, Cayuga creek, and in the upper Marcellus shale, bed F, at Plumbottom creek.

CRINOIDEA

Crinoid stems are of frequent occurrence in the upper four of the limestone beds, but no other remains of crinoids have been observed.

ANNELIDA

SPIRORBIS Lamarck

Spirorbis *sp.*

Specimens showing the transverse section only are common in beds VII and VIII, and they are found also in bed IV. They are attached to Orthoceras marcellense and O. eriense.

BRYOZOA

HEDERELLA Hall

Hederella canadensis (Nicholson)

Pal. N. Y. 6:277, pl. 65

A single zoarium, 7 mm long, was found in bed VII. It is attached to a fragment of Orthoceras, prabably O. marcellense.

Hederella cirrhosa Hall

Pal. N. Y. 6:277, pl. 65, fig. 12, 13

Found on the surface of Nephriticeras bucinum, branching loosely over an area of about 1 square inch.

REPTARIA Rolle

Reptaria stolonifera Rolle

Pal. N. Y. 6:274, pl. 65

A large zoarium branching profusely over the surface of an Orthoceras eriense was found in bed VII. Only small fragments were found in bed III.

FISTULIPORA McCoy

Fistulipora ? *sp.*

On the surface of bed V were found Bryozoa, probably of this genus, showing the circular shell apertures and the mesopores. It resembles Fistulipora ? unilinea, but the specimen is too imperfect to be fully identified.

TREMATOPORA Hall

Trematopora (Orthopora) tortalinea Hall

Pal. N. Y. 6:180, pl. 56, fig. 9

Small fragments of this species were found on the weathered surfaces of bed VI.

STICTOPORA Hall

Stictopora *sp.*

Fragments of a zoarium referable to this genus were found on the weathered surfaces of bed V. The longitudinal rows of cell apertures with intervening ridges, and the mode of branching are shown, but the specimen is too poorly preserved to be identified with certainty.

BRACHIOPODA

SCHIZOBOLUS Ulrich

Schizobolus truncatus (Hall)

Pal. N. Y. 4:23, pl. 1, 2

This species is represented by one shell from bed III. It is a fairly well preserved interior of a brachial valve with median septum and muscular scars. The lowest horizons at which this species has been previously recorded is the upper Hamilton (Moscow) shales. Its occurrence at this lower level is of interest.

CRANIA Retzius

Crania crenistriata Hall

Pal. N. Y. 4:28, pl. 3

One specimen has been found in bed VII, attached to Orthoceras marcellense.

Crania recta[1] *sp. nov.*

Pl. 9, fig. 1-3

The three specimens obtained are all upper valves. Two are molds of the external surface with minute fragments of the posterior portion of the shell retained; the third shows the exterior. The former were attached to the interior and the latter to the exterior of the living chamber of Orthoceras.

Upper valve transverse, having the form of a flattened rim with sharply elevated central portion; beak subcentral. A shallow sinus, widening toward the front, extends from the beak to the anterior margin. Outline of the valve straight on the posterior side, regularly rounded at the sides, and slightly arcuate in front. Surface marked by fine lines of growth. Under a strong magnifier the surface is seen to be minutely granulose, a feature not visible under an ordinary hand lens. Posterior adductor scars are shown on a fragment of shell remaining.

Lower valve unknown.

The characteristic features of the species are the straight posterior margin and greater transverse diameter.

---

[1] Acknowledgments are due to Charles Schuchert, for comparing these shells with other species of the genus.

Measurements of three specimens are: 1) anteroposterior 5 mm, lateral 7.8 mm; 2) anteroposterior 5 mm, lateral 6 mm; 3) anteroposterior 4 mm, lateral 5.2 mm, depth 1 mm.

CRANIELLA Oehlert

Craniella hamiltoniae (Hall)

Pal. N. Y. 4:27, pl. 3

This species is fairly common in beds VII and VIII. All the shells found are attached to Orthoceras, and are of the normal adult proportions.

STROPHEODONTA Hall

Stropheodonta (Leptostrophia) perplana Conrad

Pal. N. Y. 4:98, pl. 11, 12, 17, 19

Fragments of several individuals have been found in bed VII, and one nearly complete pedicle valve in bed VIII has a length of 19 mm and width of 25 mm.

Stropheodonta inequistriata (Conrad)

Pal. N. Y. 4:93, pl. 12

Pedicle valves of this species are fairly common in bed VII. The largest specimen found has a length of 14.5 mm and width of 21 mm. The surface markings are more delicate than those of the average specimen from the Hamilton shales, but are otherwise similar.

ORTHOTHETES Fischer de Waldheim

Orthothetes chemungensis arctostriata Hall

Pal. N. Y. 4:71, pl. 9

The specimens are much broken, but all show the characteristic sharply elevated costae and fine concentric striae. One fairly perfect mold of a pedicle valve is of the normal form and size.

CHONETES Fischer de Waldheim

Chonetes mucronatus Hall

Pal. N. Y. 4:124, pl. 20, 21

This species is common in all of the lower shales except the upper fissile part of bed D and bed E, where it has not been

observed. It becomes extremely abundant in bed I of the limestone series and is common in all the other limestone beds, but has not been found in beds F, G, and H, of the overlying shales. The specimens in the lower shales are small but are characterized by the great length of the cardinal spines (fig. 4). Individuals having exceptionally long spines are not only smaller but usually have also fewer plications. A specimen of average proportions in bed C is 5.4 mm long, 6.8 mm wide, and bears 22 plications. In bed I the majority of the shells are smaller than in the shales, but in beds II and III there is a perceptible increase in the average size of the specimens. The largest shell which could be referred to this species occurs in bed VI. It is 9 mm long, 10.4 mm wide, and has 20 plications. The single cardinal spine which is retained is nearly parallel with the hinge line.

Chonetes lepidus Hall

Pal. N. Y. 4:132, pl. 21

This is a rare species in the limestones, only two well preserved specimens having been found in bed VIII, but it becomes abundant in the shales immediately overlying the limestone. The plications on specimens from this locality are slightly less prominent than on those from the Hamilton shales.

Chonetes scitulus Hall

Pl. 9, fig. 4-6

Pal. N. Y. 4:130, pl. 21

In bed III a single well preserved individual of this species was found, but it is common in beds IV and V.

Associated with shells of the normal form and size are others which have been referred with doubt to this species. The shells are slightly transverse, the largest specimens somewhat less so than the smaller, and the hinge line equals the greatest width of the shell. The ventral valve is moderately convex with often a faint sinus along the median line which is traceable about two thirds the length of the shell, but disappears before reaching the margin. The dorsal valve has a concavity less than the con-

vexity of the opposite valve. The interior is not well shown. The surface bears fine rounded or subangular plications, which increase by bifurcation and intercalation till there are 11 or 12 in the space of 3 mm on the margin of the shell. Frequently two of these are stronger just below the beak and form the beginning of the sinus when one is present. They are crossed by fine concentric striae. There are two or three strong upward curving spines, and sometimes the base of a fourth on each side of the beak. Dimensions of specimens of average and extreme size are: 1) length 7 mm, width 9 mm; 2) length 9.6 mm, width 12.2 mm.

These specimens differ from Chonetes lineatus of the Onondaga limestone in being larger, less convex, and in the number and size of the cardinal spines.

Though the greater size, less convexity, and occasional presence of a sinus seem features of sufficient importance to constitute a new species, they are not always associated in the same specimen, and there are moreover shells which appear to form a gradation from the most extreme to the more typical specimens.

STROPHALOSIA King

Strophalosia truncata (Hall)

Pal. N. Y. 4:160, pl. 23

In beds A, B, and C, of the lower shales this species is small and comparatively rare, but in the upper shaly part of bed D it is extremely abundant and of greater size. Individuals measuring 8.6 mm in length, 11.4 mm in width, and with the truncation occupying about one sixth the area of the pedicle valve are common. In bed I they are small, extremely gibbous, and with the truncation occupying about one third the area of the valve. An average specimen measures: length 4.6 mm; width 5 mm; convexity 1.9 mm.

In beds II, III, and IV, the specimens are larger, the area of the truncation decreasing in proportion to the increase in the size of the shells. The following measurements of the largest specimens observed from beds I, II, and IV, serve to illustrate

this point. I length 7.4 mm, width 8.6 mm, truncation 1.5 mm; II length 9.8 mm, width 12 mm, truncation 1.1 mm; IV length 9.4 mm, width 12 mm, truncation 1.2 mm.

The species is rare in beds III and V, only a few fragments having been found.

PRODUCTELLA Hall

Productella spinulicosta Hall

Pal. N. Y. 4:160, pl. 23

In beds VI, VII, and VIII, specimens occur, which differ from Strophalosia truncata only in their greater size and the absence of truncation of the pedicle valve. These have since been referred to Productella by Hall and Clarke,[1] "the existence of an articular system and of cardinal areas is not sufficient of itself to distinguish Strophalosia from Productella, and it will therefore be necessary to base distinctive generic value on the umbonal attachment of the former." Neither cardinal areas nor articular system has been observed in any of these specimens.

Productella dumosa Hall

Pal. N. Y. 4:162, pl. 23

This species is rare in beds II and IV. The shell is preserved on all the specimens, and the costae which form the spine bases are slightly farther apart than on specimens from the Hamilton shales. The largest specimen found has a length of 16 mm. The width could not be measured.

RHIPIDOMELLA Oehlert

Rhipidomella vanuxemi (Hall)

Pal. N. Y. 4:47, pl. 6

The species is represented by a few specimens in bed VII. The shell is retained in a fairly perfect condition. The specimens are all pedicle valves usually showing the exterior, but one shows the interior with the large muscular scars and finely striated margin of the shell. One specimen is 15.5 mm long and 18 mm wide, but the others found are much smaller.

---

[1] Pal. N. Y. vol. 8, pt 1, p. 315.

CAMAROTOECHIA Hall & Clarke

Camarotoechia sappho (Hall)

Pal. N. Y. 4:340, pl. 54

Large and often gibbous specimens of the normal form are very common in beds VII and VIII. They are for the most part molds of the interior, but a few retain a portion of the shell.

Camarotoechia horsfordi Hall

Pal. N. Y. 4:339, pl. 54

This is a rare species at this locality. One nearly perfect specimen and several fragments have been found in bed VII. The former is a gibbous shell having five plications on the fold, four in the sinus, and five on the lateral slopes. It measures 14 mm in length and 17 mm in width.

Camarotoechia prolifica (?) (Hall)

Pl. 9, fig. 13–15

Pal. N. Y. 4:343, pl. 54 a

Several well preserved specimens in beds IV and V are referred with doubt to this species. They correspond in general proportions and number of plications to Prof. Hall's description and figures, but the plications are more sharply angular, and the umbonal part of the pedicle valve is distinctly elevated, and slopes abruptly to the cardinal margins. There is also a slight median depression near the beak of the pedicle valve.

Camarotoechia pauciplicata *sp. nov.*

Pl. 9, fig. 7–12

Associated with Camarotoechia sappho and C. horsfordi are specimens which differ from both in important respects. The outline of these shells is subpentagonal, the greatest width being two thirds the distance from the beak to the anterior margin. Pedicle valve slightly convex in the posterior portion but becoming depressed in the sinus and extended in front to meet the margin of the brachial valve. Beak elevated and slightly incurved. Brachial valve gibbous, the greatest con-

vexity being at about the middle of the shell. Surface marked by three subangular plications on the fold, two in the sinus, and three broad, low plications on the lateral slopes. These are crossed by well marked lines of growth. Plications absent near the beaks and becoming well defined at about one fourth the length of the shell from the beak. A well marked constriction of both valves is often present about half way between the beak and anterior margin. The interior could not be observed. The nearly straight cardinal slopes, elevated ventral beak, and few plications of the fold and sinus are the most characteristic features of the species.

This species resembles externally Pugnax utah of the upper Coal Measures, but the specimens are longer in proportion to the width, and the plications become visible nearer the beak than in the latter species. From Camarotoechia (?) duplicata, of the Chemung beds, it differs in the unequal convexity of the valves, straight cardinal slopes, and greater number of lateral plications. This species has been observed in bed VII only at Lancaster, but a similar shell has been found by the writer in material from the Stafford limestone of the Livonia shaft (N. Y. state museum).

• Liorhynchus limitare (Vanuxem)

Pal. N. Y. 4:356, pl. 56

There is considerable variation among the shells referred to this species in the different beds of the section. In the shales all the specimens are excessively flattened. In the upper part of bed D, some layers of which are filled with these shells, they are of all sizes from the very young, 2 mm in diameter to those measuring 19 mm in length and 22 mm in width. In the limestones they have the normal convexity of the species, and many nearly perfect specimens were found. In bed I the shells are small, the average size being, length 5.5 mm, width 8 mm. In beds II and III, there is a gradual increase in size till in the latter bed the dimensions become, length 12.1 mm, width 15 mm, convexity 8 mm. In the uncompressed specimens the plications are

slightly if at all less conspicuous on the lateral slopes than on other parts of the shell. Small specimens, probably the young of this species, have a distinct median depression on the brachial valve. These shells have distinct radiating striae, while many of the same size in the shales show only faint traces of striae.

CRYPTONELLA Hall

Cryptonella rectirostris Hall

Pal. N. Y. 4:394, pl. 61

The species is represented in bed VII by several partially exfoliated pedicle valves. The dimensions of an average specimen are, length 4.6 mm, width 13 mm.

Cryptonella planirostris Hall

Pal. N. Y. 4:395, pl. 61

A single large specimen was found in bed VIII. It is easily recognized by the angular margins of the umbonal slopes, and the flattened areas on either side of the deltidial plates.

TROPIDOLEPTUS Hall

Tropidoleptus carinatus (Conrad)

Pal. N. Y. 4:407, pl. 62

This species is fairly represented in the lower shales, but only one specimen has been found in the limestone. The shell in bed V is much smaller than the average Hamilton specimen, but is similar in form and size to the majority of those found in the shales at Plumbottom creek. It is 7 mm long, by 8.2 mm wide. The largest specimen found in the shales has a length of 9 mm and width of 10.5 mm.

ATRYPA Dalman

Atrypa spinosa Hall

Pal. N. Y. 4:322, pl. 53a

One rather small shell of this species was found in bed V. The strong radiating plications and projecting concentric lamellae are preserved.

SPIRIFER Sowerby

Spirifer mucronatus (Conrad)

Pal. N. Y. 4:216, pl. 34

Fragments of these shells are found in beds V and VI at Plumbottom creek, and large and fairly well preserved specimens in the same beds at Cayuga creek.

Spirifer (Martinia) subumbona Hall

Pal. N. Y. 4:234, pl. 33

Young and exfoliated shells of this species are with difficulty distinguished from Ambocoelia nana, but the specimens are proportionally broader and the sinus less pronounced. The adult is larger, an average sized shell having the dimensions: length 9 mm, width 11 mm. These shells are extremely common in bed II.

RETICULARIA McCoy

Reticularia fimbriata (Conrad)

Pal. N. Y. 4:214, pl. 33

This species is represented by very perfect molds of the interior in which a part of the shell is sometimes retained. A specimen of average size measures: length 20 mm, width 29 mm. The shells are fairly common in beds VI and VII.

AMBOCOELIA Hall

Ambocoelia nana Grabau

Pl. 9, fig. 21–23

Geology and paleontology of Eighteen-mile creek, p. 217

Perfect specimens agreeing with the description of the type, abound in bed I, but in the shales below, specimens occur which show two types of variation. Here the more common form has the usual proportions of Ambocoelia nana, but the pedicle valve has an exceptionally deep sinus with strong and closely set spines. The spine pits are deep and not greatly elongated. The brachial valve has the typical convexity and broad shallow sinus. Average dimensions are: length 6 mm, width

7.9 mm. In the other form the sinus is shallow and the surface pits elongated and faintly marked. The brachial valve corresponds with the type. These specimens are also slightly larger, measuring 7 mm by 9 mm. There are, however, intermediate forms connecting these two extremes.

In bed I the average shell measures: length 5.3 mm, width 7.2 mm; but in the upper limestone beds they agree in size with the largest specimens in the shales.

TREMATOSPIRA Hall

Trematospira gibbosa Hall

Pal. N. Y. 4:272, pl. 45

A nearly perfect specimen was found in bed VII, and numerous incomplete shells in bed VIII. They are partially exfoliated, but show the characteristic punctate surface and crowded plications of the fold and sinus.

NUCLEOSPIRA Hall

Nucleospira concinna Hall

Pal. N. Y. 4:279, pl. 45

Shells of this species are rare in bed III. A few partially exfoliated specimens showing the subequally convex valves and characteristic surface markings were found. Measurements: length 7 mm, width 8.5 mm, convexity 3.5 mm.

MERISTELLA Hall

Meristella barrisi Hall

Pal. N. Y. 4:304, pl. 69

This is the most common fossil in beds VII and VIII. The shells are large, some of them extremely gibbous, and they exhibit the characteristic features of the species. Several specimens have been found in bed F immediately above the limestone.

Meristella meta Hall

Pal. N. Y. 4:308, pl. 49

A well preserved specimen in bed I is referred to this species. It differs from Meristella barrisi in the smaller size and in the presence of a distinct angular sinus beginning about one third of the distance from posterior to anterior margin. The cardinal slopes are somewhat flattened.

PELECYPODA

PANENKA Barrande

Panenka mollis Hall

Pal. N. Y. vol. 5, pt 1, p. 420, pl. 80

One specimen apparently of this species was found in bed VIII. It is smaller than the type, being only 8.6 mm high, by 9.2 mm long, but it agrees with the latter in other respects.

Panenka lincklaeni Hall

Pal. N. Y. vol. 5, pt 1, p. 420, pl. 69

This species has not been observed at the Plumbottom creek locality, but appears to be fairly common in bed I at the corner of Buffum and Seneca streets, Buffalo. The specimens are nearly perfect casts showing the flattened distant plications and rounded form characteristic of the species. A shell of average size is 59 mm long, and 50 mm high.

LEPTODESMA Hall

Leptodesma marcellense Hall

Pl. 9, fig. 16, 17

Pal. N. Y. vol. 5, pt 1, p. 175, pl. 17

Associated with specimens which show the normal characteristics of the species are others somewhat less oblique. The character and amount of variation may be seen by a comparison of the drawings here given, from specimens from beds II and V. A single nearly perfect specimen was found in bed C of the lower shales.

LUNULICARDIUM Münster

Lunulicardium fragile Hall

Pl. 9, fig. 18, 19

Pal. N. Y. vol. 5, pt 1, p. 434, pl. 71

A large, nearly perfect shell of this species was found in bed VII. It differs from the type in the greater development of the posterior expansion of the shell, a feature which is also characteristic of the majority of the specimens in the lower shales, but shells of the normal form are associated with these.

ACTINOPTERIA Hall

Actinopteria muricata Hall

Pal. N. Y. vol. 5, pt 1, p. 108, pl. 17

This species is represented in beds VI and VII by small casts of the left valve. They show the character of the surface markings and the form of the shell. The marginal spines are not preserved.

PTERINOPECTEN Hall

Pterinopecten exfoliatus Hall

Pal. N. Y. vol. 5, pt 1, p. 61, pl. 1, 83

Shells of this species are small, the largest found being only 10 mm high and 12 mm long. A part of the shell is retained and shows the surface markings. Only a few specimens have been found.

CYPRICARDINIA Hall

Cypricardinia indenta (Conrad)

Pal. N. Y. vol. 5, pt 1, p. 485, pl. 79

This is the most abundant species in bed VI. Some of the specimens retain parts of the shell, and the concentric lamellae are strongly marked on all of them, but only one shows faint traces of the fine radiating striae.

GASTROPODA

PLEUROTOMARIA De France

Pleurotomaria lucina Hall

Pal. N. Y. vol. 5, pt 2, p. 67, pl. 18

Large and well preserved, but somewhat compressed representatives of this species were found in bed VII. The shell is not retained, but the spiral and transverse striae are distinctly shown on the surface of the cast.

Pleurotomaria itys Hall

Pal. N. Y. vol. 5, pt 2, p. 76, pl. 20

The specimens of this species are rather poorly preserved casts retaining three whorls of the spire, but the form and surface markings are sufficiently distinct for identification.

Pleurotomaria capillaria *var.* rustica (Conrad)

Pal. N. Y. vol. 5, pt 2, p. 77

All the representatives of the species at this locality are small. A very perfect cast was found in bed II, having the dimensions: hight 5.5 mm, greatest width 6.5 mm. Three whorls are retained, all of which show the finer surface ornamentation and the spiral band.

Pleurotomaria ella Hall

Pal. N. Y. vol. 5, pt 2, p. 72

Fairly perfect molds of this shell have been found in fragments of the Stafford limestone thrown out in digging the sewer trenches on Buffum street, but the bed from which they came is not known.

Pleurotomaria sp.

In bed IV is a small species having the general shape and spiral band characteristic of the genus. The surface markings being obliterated, no specific determination could be made.

ONYCHOCHILUS Lindström

Onychochilus (?) nitidulus? Clarke

Pl. 9, fig. 20

N. Y. state geol. 13th an. rep't. 1894. p. 172, pl. 4

In bed III is found a minute sinistrally coiled gastropod which corresponds with Clarke's description and figures except that, instead of a faint carination of the whorls, there is a distinct spiral band. The concentric growth lines are interrupted in passing over this band, which is apparently partially filled by foreign matter. This feature is well shown on the body whorls of one specimen only, but, if the discovery of other specimens confirm this observation, they should be referred to the genus Hesperiella of Holzapfel rather than Onychochilus, with which I have doubtfully placed my specimens.

LOXONEMA Phillips

Loxonema *sp.*

Several longitudinal sections, having the general proportions of Loxonema hamiltoniae, were seen on the weathered surface of bed III, and a few whorls possibly of the same species in bed II.

PLATYCERAS Conrad

Platyceras (Orthonychia) attenuatum Hall

Pal. N. Y. vol. 5, pt 2, p. 6, pl. 3

A single compressed specimen was found in bed VI. The small apex and undulating lines of growth are well shown. Its length is 25 mm, and width at the peristome 20 mm.

PTEROPODA

STYLIOLINA Karpinsky

Styliolina fissurella (Hall)

Pal. N. Y. vol. 5, pt 2, p. 178, pl. 31

This species is found in bed VII of the limestones where it is sparingly represented, but it is extremely common in the shales, being found in all the beds both below and above the limestone. Nearly all the shells show a line of fracture along the median line, due to compression.

COLEOLUS Hall

Coleolus tenuicinctus Hall

Pal. N. Y. vol. 5, pt 2, p. 185, pl. 32

A single specimen in bed I, shows the faint striae characteristic of the species. Several specimens in bed III are referred with doubt to this species. The shell is replaced by finely crystallized calcite and the surface markings consequently obliterated. The largest specimen observed has a length of 65 mm and greatest diameter of 5 mm.

CEPHALOPODA

ORTHOCERAS Breyn

Orthoceras exile Hall

Pal. N. Y. vol. 5, pt 2, p. 290, pl. 39, 84, 85

This species is fairly common in beds I, II and III. The specimens are molds of the interior. The apical angle is about 6°, and the depth of the air chambers is from 3 to 5 mm. The largest specimen is 75 mm long, and retains a part of the living chamber and 12 septa.

Orthoceras marcellense Vanuxem

Pal. N. Y. vol. 5, pt 2, p. 278, pl. 38, 39, 93

This species, like O. exile, is represented by internal molds which are somewhat compressed. They are identified by means of the distant septa and regularly enlarging tube. The apical angle is 8°, and the depth of the air chambers 6 to 8 mm. The largest specimen is 125 mm long, and a part of the living chamber and nine septa are preserved. The position of the siphuncle could not be determined.

Orthoceras eriense Hall

Pal. N. Y. vol. 5, pt 2, p. 274, pl. 40

A fine specimen of this large species was found in bed VII. It is 180 mm long, and 45 mm wide at the smaller end. It shows a part of the chamber of habitation and nine air chambers, which vary in depth from 9 to 13.5 mm. The apical angle is 7.5°.

The surface of this Orthoceras is covered with Bryozoa, Crania, and Spirorbis.

Orthoceras aegea Hall

Pal. N. Y. vol. 5, pt 2, p. 295, pl. 82

The representatives of this species in the limestone are small, the most perfect specimen being only 14.5 mm long, and having a greatest diameter of 6 mm, but fragments of a larger specimen were found. In bed F of the upper shales large specimens were found and fragments of the shell retain all the characteristic features of the surface.

Orthoceras fenestrulatum Clarke

N. Y. state geol. 13th an. rep't. 1894. 1:168, pl. 2

In bed VIII a large internal mold was found to which bits of the shell still adhere. It is 53 mm long, and has a greatest diameter of 29 mm. The surface ornamentation has been sufficiently impressed on the mold to show its character distinctly. Other specimens are portions of the thin shell, showing the inner surface and the external ornamentation reversed.

NEPHRITICERAS Hyatt

Nephriticeras bucinum (Hall)

Pal. N. Y. vol. 5, pt 2, p. 412, pl. 106, 107, 109

A large cast showing distinctly the finer surface ornamentation and the position of the septa was found in bed VII. Its length is 70 mm and greatest diameter 44 mm. Portions of the surface are overgrown with Bryozoa.

CRUSTACEA

TRILOBITA

PHACOPS Emmrich

Phacops rana (Green)

Pal. N. Y. vol. 7, p. 19, pl. 7, 8, 8a

This species is common in the lower limestone beds and sparingly represented in the upper. Portions of the cephalon and pygidium were found. Some of the specimens referred to

this species show the protuberant glabella characteristic of Phacops cristata, but the lateral crenulations of the submarginal furrow are absent, and other features characteristic of the species are not shown.

CRYPHAEUS Green

Cryphaeus boothi Green

Pal. N. Y. 7:42, pl. 16, 16a

This is a rare species at Plumbottom creek. It is represented by fragments of the cephalon and pygidium. A small specimen in bed V shows the genal spines and strongly pustulose glabella.

CYPHASPIS Burmeister

Cyphaspis craspedota Hall

Pal. N. Y. 7:148, pl. 24

A few specimens of this species have been found in beds V and VII. A cephalon from bed V shows the pustulose glabella, palpebral lobes, marginal sulcus and one genal spine. It is 4 mm long, and 8 mm wide. The spine is 2.8 mm in length.

OSTRACODA

PRIMITIOPSIS Jones

Primitiopsis punctulifera Hall

N. Y. state mus. 13th an. rep't. 1860. p. 92

This is a rare fossil at this locality, but when found the shells are usually well preserved, showing the form and reticulated surface markings.

From a consideration of the lithologic character of the different beds, at this locality, and the size and distribution of the contained fossils, successive changes in physical conditions may be inferred. Though the change from shale to limestone was a somewhat abrupt one, the limestone at first retained considerable carbonaceous material, as shown by the dark color and limited number of species in bed I. In beds II and III a gradual clearing of the water is indicated by the increasing purity of the

limestone, which, in bed III is fine grained, hard, and light colored. Bed D marks, by its darker color, a tendency to return to former conditions, and V and VI are impure and somewhat shaly limestones. The changes in physical conditions thus indicated are reflected, as one might expect, in the character and condition of the organic remains. Thus, there is a gradual increase in size as well as in number of species from bed I to bed III, while the reverse is true from bed IV to VI, in which a small lamellibranch becomes the most abundant fossil. These are succeeded by a return to clear water conditions, for VII and VIII are to an even greater extent than bed III pure hard limestones containing a great abundance and variety of fossil remains. As already noted, they represent the time of maximum development of the fauna. The change to muddier waters and a Marcellus fauna is an abrupt one, as indicated by the thin bedded dark shales and Liorhynchus fauna of bed F.

CONCLUSION

The base of the Marcellus is reported by Prof. I. P. Bishop[1] to be 20 feet below the limestone layers. The thickness of the limestone is 8 feet, 4 inches, and the estimated thickness of the Marcellus in western New York 140 feet. The top of the limestone must therefore be not less than 111 feet below the base of the Hamilton. Though occurring so far below the latter formation, the fossils of the Plumbottom creek limestones are, as indicated by the foregoing lists, largely Hamilton species with a few typical Marcellus forms and several persistent species from the Onondaga limestone.

Of the 72 species recognized from the limestone at Lancaster 54 occur in the Hamilton, 15 species are common to both Hamilton and the Marcellus shales, eight are exclusively Marcellus, 11 have been reported from the Onondaga limestone, and two are restricted to the Stafford limestone. The shales below and above the limestone contain typical Marcellus fossils. It will thus be seen that the conditions favorable to the formation of the thin bedded dark shale, with its characteristically Marcellus

[1] Structural and economic geology of Erie county, p. 314.

fauna, was succeeded by a limestone-making epoch with clearing waters, and a typical Hamilton fauna which had migrated from some, at present, unknown locality. This was followed by a return of the Marcellus fauna when the waters were again more shallow and less pure.

The existence of a Hamilton fauna in the Stafford limestone at Stafford and Livonia has already been noted by John M. Clarke.[1] His list of species for both localities comprises two Anthozoa, one Crinoid, four Bryozoa, 27 Brachiopoda, 10 Lamellibranchiata, 14 Gastropoda, one Pteropod, 10 Cephalopoda, six Arthropoda and one Annelid, a total of 76 species, of which two Bryozoa, 16 Brachiopoda, three Lamellibranchiata, five Gastropoda, two Pteropoda, three Cephalopoda, and three Arthropoda, a total of 34 species, have been found at Lancaster, that is, about half the total fauna of the Lancaster limestone is present in the Stafford limestone. The most characteristic species of the section under consideration are Strophalosia truncata, Spirifer subumbona, Meristella barrisi, Camarotoechia sappho, Phacops rana, Orthoceras marcellense, O. exile, Liorhynchus limitare, Reticularia fimbriata, and Cypricardinia indenta, of which the first six are found in the Stafford limestone.

A comparison of material from the Stafford limestone of these localities in the New York state museum at Albany reveals a close correspondence in lithologic character and fossils with beds VII and VIII, 15 species restricted to these two upper beds being found in the Stafford limestone. Liorhynchus limitare which is common in the lower beds is absent from the three upper beds of the section and absent also from the sections cited. The thickness of this limestone is given as from 18 inches to 2 feet, while the combined thickness of beds VII and VIII is 2 feet 2 inches. These facts seem to warrant a definite correlation of beds VII and VIII with the 2 feet of limestone exposed at Stafford.

[1] In work cited, and Succession of the fossil faunas in the section of the Livonia salt shaft; N. Y. state geol. 13th an. rep't. 1894. p. 131.

Farther east the thickness of the Stafford limestone is shown by borings in various salt shafts to be 1.8 feet at Leroy; and in Livingston county, 4 feet at York, 1 foot at the outlet of Conesus lake, and 2 feet at Livonia. Westward the conditions appear to be somewhat different, for at the Plumbottom creek locality, only about 30 miles west from Stafford, the thickness is 8 feet 4 inches. The only locality between these places at which the Stafford limestone has been observed is at Wende station on the Lehigh railroad. The contact between the lower Marcellus shales and bed I is well exposed on the left bank of the stream opposite the station. Large boulders, some of which belong to higher beds of the Lancaster section, are scattered along the stream channel to the southward for a distance of ½ mile or more but there are no exposures from which the thickness of the limestone could be estimated. An outcrop supposed to be of this Stafford limestone occurs on the farm of Martin Martin ½ mile east of Alden Center, but this proved on examination to belong to the Onondaga formation. The exposure is due to the removal of the surface soil over an area 3 or 4 yards square, and the rock has been blasted, fragments of it having been thrown out on the surface. The rock resembles the Stafford limestone lithologically but the fossils are mainly corals of the genera Favosites, Zaphrentis, Heliophyllum and Blothrophyllum, B. promissum being the most common species. The following are a few of the fossils observed at this locality.

Zaphrentis prolifica *Billings*
Z. gigantea (?) *Lesueur*
Z. herzeri (?) *Hall*
Z. *sp.*
Blothrophyllum promissum *Hall*
Cyathophyllum (Heliophyllum) juvenis *Rominger*
Heliophyllum corniculum (*Lesueur*)
Favosites epidermatus *Rominger*
F. hemisphericus *Troost*

Syringopora *sp.*
Pentamerella arata (*Conrad*)
Reticularia fimbriata (*Conrad*)
Phacops rana (*Green*)

The contact between the Marcellus and Onondaga is supposed to be about half way between Wende station and Mill Grove.[1] The eastward extension of this line of contact would carry it about a mile north of the outcrop of Onondaga limestone at Alden. The occurrence of the latter limestone so far to the south may perhaps best be accounted for by postulating a gentle undulation of the strata in this region. Only a slight elevation need be assumed, for the top of the Onondaga is reported to be only 20 feet below the Stafford limestone, and the locality at Wende where the base of the latter is exposed is about 2½ miles from the outcrop of Onondaga at Alden. An elevation, therefore, of 20 feet in a distance of 2½ miles would be sufficient to bring the Onondaga to the surface, and the extent of deflection of the outcrop would depend on the shape of the fold.

West of Lancaster an outcrop of limestone in the bed of Buffalo creek below Gardenville appears, from its lithologic character and its relations to the Marcellus shales, to correspond with bed H of the Plumbottom creek section.

The Stafford limestone was passed through in digging the sewer trenches near the corner of Buffum and Seneca streets, but for the thickness at this locality no accurate data could be secured. Another exposure of Stafford limestone in Erie county is mentioned by Bishop at the point where the Buffalo, Rochester and Pittsburg railroad diverges from the Western New York and Pennsylvania, and the Lake Shore railroads, but the thickness is not given. From these facts it appears that the limestone forms as bed rock, a band approximately ⅓ to ½ a mile wide extending across the county in a slightly southwest direction from the vicinity of Wende station to Lake Erie.

The rapid increase in thickness in the comparatively short distance between Stafford and Plumbottom creek and the

[1] Bishop. Structural and economic geology of Erie county.

correlation of the two upper beds of the sections at the latter place with the Stafford limestone suggests the possibility of correlating beds I to VII with the lower Marcellus rather than with the Stafford limestone. To this may be objected the continuity of the Plumbottom creek limestones and their fauna, and the occurrence of characteristic Stafford species throughout the section. The prevailing species in the Stafford limestone at Livonia, as given by Clarke, are: Strophalosia truncata, Chonetes scitulus, Meristella barrisi, Camarotoechia horsfordi, and Phacops rana. Of these Strophalosia truncata, Chonetes scitulus, and Phacops rana are characteristic of the lower, and Meristella barrisi, and Camarotoechia horsfordi of the upper beds.

Beds I to IV as well as VII and VIII are, like the typical Stafford limestone, a dark subcrystalline rock when fresh, weathering gray and with the substance of the fossils altered to a dark crystalline calcite. The difference in the thickness may be accounted for by the fact that the section at Stafford has never been described in full, and it may be either that the lower calcareous beds of the Lancaster section are wanting or that they are concealed there.

Notwithstanding the differences noted above between the faunal lists from Stafford and Plumbottom creek the section at the latter place exhibits all the more characteristic features of the Stafford limestone fauna, and there is no break either lithologically or faunally sufficiently marked to warrant a correlation of the lower and upper portions of the section with different formations. We may therefore conclude that the section at Lancaster represents the westward extension of the Stafford limestone, but with greater thickness and differentiation into distinct beds, of which the lower may be absent at Stafford or more probably, concealed at that place.

Vertical distribution of the Stafford limestone fauna at Lancaster N. Y.

	LANCASTER															NEW YORK STATE OTHER THAN LANCASTER			
	Marcellus shale					Marcellus limestone								Marcellus shale					
	A	B	C	D	E	I	II	III	IV	V	VI	VII	VIII	F	G	Onondaga limestone	Marcellus shale	Stafford limestone	Hamilton
Actinopteria muricata											X	X					X	X	
Ambocoelia nana		X	X	X	X	X	X	X	X	X		X	X				X		X
A. praeumbona	X																		X
A. umbonata														X		X	X	X	X
Atrypa spinosa										X						X			X
A. reticularis														X		X	X	X	X
Aulopora sp												X							
Aviculopecten exacutus			X	X													X		X
Camarotoechia horsfordi												X					X	X	X
C. pauciplicata												X						X	
C. prolifica ?									X	X								X	X
C. sappho											X	X	X					X	X
Ceratopora dichotoma										X				X	X				X
C. jacksoni									X	X									X
Chonetes lepidus												X		X			X	X	X
C. mucronatus	X	X	X	X		X	X	X	X	X	X	X	X			X	X	X	X
C. scitulus					X		X	X		X	X						X	X	X
Coleolus tenuicinctum							X	X											X
Crania crenistriata												X							X
C. recta												X							
Craniella hamiltoniae									X			X	X				X	X	X
Cryphaeus boothi										X	X	X				X		X	X
Cryptonella planirostris												X	X					X	X
C. rectirostris												X							X
Cyphaspis craspedota										X		X						X	X

	LANCASTER															NEW YORK STATE OTHER THAN LANCASTER			
	Marcellus shale					Stafford limestone								Marcellus shale		Onondaga limestone	Marcellus shale	Stafford limestone	Hamilton
	A	B	C	D	E	I	II	III	IV	V	VI	VII	VIII	F	G				
Cypricardinia indenta									X		X		X			X			X
Favosites placenta											X	X							X
Fistulipora ? sp.										X									
Goniatites ?		X		X															
G. vanuxemi (?)			X																
Hederella canadensis												X						X	X
H. cirrhosa									X			X							X
Isochilina (?) fabacea	X	X	X	X	X														X
Leptodesma marcellense			X				X	X		X							X		
Liorhynchus limitare	X	X	X	X		X	X	X	X	X				X	X		X		
Loxonema sp.							X	X											
Lunulicardium curtum			X																
L. fragile	X	X	X	X	X							X		X			X	X	X
Meristella barrisi								X				X	X	X				X	X
M. meta						X													X
Modiomorpha subalata	X	X	X														X		X
Nephriticeras bucinum												X							X
Nucleospira concinna								X								X			X
Nuculites nyssa	X	X	X														X		X
N. triqueter		X	X	X	X												X		X
Onychochilus (?) nitidulus (?)							X	X										X	
Orthoceras aegea												X						X	X
O. eriense												X							X
O. exile						X	X	X											X

Orthoceras fenestrulatum	...	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	X	...
O. marcellense	...	...	...	...	...	...	X	...	...	...	...	X	X	...	...	...	X	X	...
O. subulatum	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...	...	X	X	X
Orthonota parvula	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	X
Orthothetes chemungensis arctostriata	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	X	X
Palaeoneilo sp	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...
Panenka linckleani	...	...	...	...	X	X	...	...	...	...	...	...	...	...	...	...	X	X	...
P. mollis	...	...	...	...	...	...	...	...	...	...	...	...	X	...	...	...	X	...	...
P. rana	...	...	...	...	...	...	X	X	X	X	X	X	X	X	...	X	X	X	X
Platyceras (Orthonychia) attenuatum	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	X	X
Pleurotomaria capillaria rustica	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	X	X	X
P. itys	...	...	...	...	...	...	X	X	...	...	...	...	...	...	...	...	...	X	X
P. lucina	...	...	...	...	...	...	...	...	...	...	...	X	...	...	...	X	...	X	X
P. rugulata	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	X	X	...
P. ella	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X
P. sp	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...
Primitiopsis punctulifera	X	...	...	...	X	...	X	X	...	...	...	...	X	...	...	...	...	...	X
Productella dumosa	...	...	...	...	...	...	X	...	X	...	...	...	...	...	...	...	...	...	X
P. spinulicosta	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	X	X	X
Pterinopecten exfoliatus	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	...	X	...
Reptaria stolonifera	...	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	X	X	X
Reticularia fimbriata	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	X	X	...	X
Rhipidomella vanuxemi	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	X	X
Schizobolus truncatus	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	X
Spirifer mucronatus	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	X	...	X
S. (Martinia) subumbona	...	...	...	...	...	...	X	X	X	X	...	X	...	...	...	...	...	X	X
Spirorbis sp	...	...	...	...	...	...	...	...	X	...	...	X	X	...	...	...	...	...	...
Stereolasma rectum	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	...	X
Stictopora sp	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...
Strophalosia truncata	X	X	X	X	...	X	X	X	X	X	...	...	...	...	...	...	X	X	X
Stropheodonta inequistriata	...	...	...	...	...	...	...	...	...	...	...	X	...	...	...	X	...	X	X
S. perplana	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	X	...	...	X
Styliolina fissurella	X	X	X	X	...	...	...	...	...	...	...	X	...	X	X	...	...	X	X
Tentaculites gracilistriatus	...	...	...	...	...	...	...	...	...	...	X	...	X	...	...	...	X	X	X
Trematospira gibbosa	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	...	X
Trematopora (Orthopora) tortalinea	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	X
Tropidoleptus carinatus	...	X	...	X	...	...	...	...	...	X	...	...	...	...	...	...	...	...	X

NEW AGELACRINITES

BY JOHN M. CLARKE

Pl. 10

Some interesting specimens of new agelacrinites have been acquired recently from the upper Devonic and supradevonic sandstones in southwestern New York and northeastern Pennsylvania. The first suggestion of these came to my notice several years ago through the kindness of E. B. Hall esq. of Wellsville, who presented me with a hand-size slab bearing impressions of the aboral surface of four large disks, with parts of not less than five others. This specimen was a loose Chemung sandstone slab found at Belvidere, Allegany co. Subsequently another specimen similarly preserved was found loose near Wellsville. Though the novelty of this species to our Chemung faunas was recognized, the specimens were laid aside to await more light on the essential characters of the organism. Through the assiduity of two zealous students of the Chemung fauna, Laurence LaForge and Prof. Charles Butts of Alfred N. Y., the desired facts have arrived. These gentlemen have brought to light in the vicinity of Alfred a very considerable number of specimens of this agelacrinite, displaying variations in size that indicate different stages of growth and in a large majority of cases affording the oral exposure. Mr Butts has also obtained specimens of this organism at a locality 2 miles south of Sabinsville, in the town of Clymer, Tioga co. Pa. and these, by the courtesy of the director of the U. S. geological survey I have been allowed to study and figure. While discussing the structure of this species, I shall provisionally refer to it as A. a l l e g a n i u s. The state museum has come into possession of an excellent series of these novel fossils.

While engaged in field work on the Olean quadrangle during the season of 1900, Mr Butts also obtained from a very high horizon in the sandstones of that region another small and rather

obscure agelacrinite, fuller reference to the structure and stratigraphic position of which will be made, and which will now be termed A. buttsi. Prof. Beecher of New Haven has kindly called my attention to a specimen of this species obtained by him from approximately the same horizon in the rock section at Warren Pa., and has also placed in my hands for study a new species from a higher horizon in the early Carbonic strata at the same place. This we refer to as A. beecheri.

The fauna of the Chemung beds is one of constant surprises, and in its arenaceous deposits, in places crowded with long known brachiopods, lamellibranchs, etc. it is the unexpected that happens to the persistent searcher. The vast amount of material brought in from these rocks for the study of the fauna of the period as described in the various volumes of the *Paleontology of New York* produced none of these agelacrinites, nor of the remarkable phyllocarid crustaceans described by Prof. Beecher and by the writer, of the limuloid described by Prof. H. S. Williams, nor of the starfishes recently obtained by the collectors of this department for the state museum, and but very few of the hexactinellid sponges of which the late Prof. Hall and the writer have described 70 species. This fauna should appeal to collector-students, who may be blessed at any turn therein with paleontologic surprise and gratification.

That the agelacrinites under special consideration were not after all extremely rare members of the Chemung fauna, is testified by a slab bearing 13 impressions, now the property of Mr LaForge, the finder. One slab owned by the museum bears seven individuals exposing the oral surface, and another nine with aboral exposure.

In studying these organisms, which their novel relation to our ancient fauna and their interesting biologic character entitle to description and illustration, a comedy of errors in the nomenclature and determination of its allies among the Agelacrinitidae reveals itself. If, therefore, these bodies prove a means to unsnarl the tangle of names into which American paleontologists with the aid of their British and German brethren have plunged

these organisms, they may thereby also do a service. Before, then, proceeding to a special account of these bodies I shall undertake a brief historical exordium. Without this one dare not employ the outstanding generic names.

The term, Agelacrinus, employed even by so late and accomplished an author as Bather[1] is not entitled to the respect it has received. It has been long in use, but usage can not be granted to play as important a part in the construction of a scientific nomenclature as in the building of a language. *Agelacrinites* was the original form of the word as employed by Vanuxem for his unique fossil, A. hamiltonensis.[2] A later well intentioned writer conceived it wise to drop the *ites* and add the *us*, as was then doing with names of crinoidal genera which had been terminated with the former syllables. Not only are the author's rights conserved, but the differentials of the genus are indicated by the retention of the original word. Various distinguished authors, Meek and Worthen, Billings and Jaekel have eschewed the substitute, but the wrong word is still in active service.

Meek and Worthen[3] were the first to recognize by name what they believed to be a generic difference between the middle Devonic Agelacrinites and the species from the Siluric and lower Carbonic which were all being included under that name; a difference in the character of the plates, imbricating in the latter and juxtaposed in the former; and in the direction of the arms, two of the five being dextral (solar[4]) in the former, and but one dextral in the latter. They proposed to distinguish the latter by the term, Lepidodiscus, and, as this name was employed first in connection with their species, Ag. (Lep.) squamosus of the Keokuk limestone, we must assume this to be the type species of that proposed division. Thus restricted it is clear that

[1] Lankester's Treatise on zoology. 1900. pt 3.

[2] Geol. N. Y. 3d geol. district. 1842. p. 158, fig. on p. 306.

[3] Geol. sur. Ill. 1873. 5:513.

[4] Jaekel proposes to distinguish the rays in these bodies according to their direction by comparing them to the apparent motion of the sun or the course of the hands of a clock. Thus right under to left and over to right (dextral) is *solar*, the opposite direction (sinistral) *contrasolar*. The terms are helpful and we have here employed them.

the name can not appropriately be applied to Siluric forms like A. cincinnatiensis.

Let us take a short step backward. Prof. Hall in 1868[1] had described an agelacrinite from the Kaskaskia (Chester) limestone (Kaskaskia Ill.) as Agelacrinites kaskaskiensis. The figure of the specimen represented five long and slender arms, all directed up and over to the left (sinistral or contrasolar), but the description ascribes six rays to the fossil. Meek and Worthen having the type specimen before them, pointed out that there were but five arms, and that, if there was an appearance of a sixth, it was due to an imperfection in the specimen. Prof. C. A. Rolfe of the Illinois state university has kindly provided me with a photograph and squeeze of this original, from which it is clear, not only that there are indeed five rays, but that they are not all contrasolar, as represented by Hall and also in the figure reproduced by Keyes,[2] but that only four are contrasolar, while the fifth is solar; and in this respect at least the species conforms to the type of Lepidodiscus. To the other features of its structure subsequent reference will be made.

FIG. 1 The original specimen of A. kaskaskiensis Hall showing R 1-4 contrasolar, R 5 solar, and the mosaic pavement of the interradii. Natural size

In 1883 Worthen and Miller[3] introduced the generic term, Echinodiscus, with a single species, E. optatus, from the Chester limestone of Illinois. The single figure given of the species, and all that has ever been presented, shows what is alleged to be a segment of the aboral surface. Of itself it serves to define nothing, affording no clue either to generic or specific structures. As establishing either species or genus it is practically worthless. Notwithstanding this fact, the definition given of both species and genus is full and clear, describing all the main features of the theca and ambulacra. One can not fail of conviction, nor therein be far from the truth, that in the

[1] Geol. Iowa. v. 1, pt 2, p. 696, pl. 25, fig. 18.
[2] Geol. Missouri. Pal. 1894. v. 4, pt 1, p. 133, pl. 18, fig. 3.
[3] Geol. sur. Ill. 8:335, pl. 31, fig. 9.

preparation of this account the authors were relying mainly on the original specimen of A g e l. k a s k a s k i e n s i s Hall, which belonged to the Worthen collection. That E c h. o p t a t u s W. & M. is not the same thing as A. k a s k a s k i e n s i s has not been proven, and every indication favors the presumption that it is. Side light is thrown on this proposition by two facts, viz, that in the description of Echinodiscus and E. o p t a t u s, the remotest reference to A. k a s k a s k i e n s i s is avoided, and also that in the edition of Miller's *North American geology and paleontology* (1889) next succeeding the date of Worthen and Miller's publication, A. k a s k a s k i e n s i s is referred to Echinodiscus. The basis of the genus Echinodiscus was laid mainly on the constitution of its interradial plating, which is not imbricating but mosaic, on the mode of departure of the ambulacra from the oral aperture and the narrowness of the rays, but nothing is said concerning the direction of the rays.

Mr Miller subsequently described[1] another species of this genus, E. s a m p s o n i, from the Keokuk group at Boonville Mo., a highly incomplete fragment of the oral surface, which nevertheless shows narrow, undulating ridgelike rays and a mosaic of polygonal interradial plates. Except for its larger size there is little to distinguish it from A. k a s k a s k i e n s i s.

So far then it appears that a quite distinct type of structure among the agelacrinites has been founded on specimens one of which was fairly complete but incorrectly described, a second audaciously fragmentary and imperfect and a third likewise imperfect but affording some important details.

The specimen for which F. Roemer proposed the name Haplocystites (H. r h e n a n a, 1851) has recently been figured by Jaekel (*Stammesgeschichte der Pelmatozoen*. 1899. pl. 3, fig. 3). This is an internal cast showing two rays and part of a third. These are quite narrow and have the general aspect of those of Agelacrinites while the plates are polygonal and mosaic. The surfaces of these plates are smooth as in E c h i n. s a m p s o n i and A. k a s k a s k i e n s i s but as the specimen

[1] Geol. sur. Ind. 17th an. rep't. 1891. p. 76, pl. 12, fig. 16.

shows only the under surface, it is not yet possible to state that they were not sculptured exteriorly like A. hamiltonensis. Jaekel thus has wisely regarded Haplocystites synonymous with Agelacrinites. Future knowledge of this fossil may indicate that Haplocystites is the proper designation for the bodies which have been termed Echinodiscus or Lepidodiscus.

Agelacystis is a name proposed by Haeckel as a substitute for Agelacrinites because the latter is not a crinoid. It has no standing whatever.

Great minds have ever thought in unison. And so it came about that in the year 1897 it was discovered by the acute American paleontologist, Mr. Miller,[1] and by the distinguished English geologist and explorer, Dr J. W. Gregory,[2] that the term Echinodiscus had long ago been employed as a generic name among the Echinoderma, and hence its duplication was inadmissible. Mr Miller exercised his preeminent right to correct his error by proposing to replace the unintended synonym with the word, Ageladiscus.[3] This was in October of that year, but already in February Dr Gregory had introduced the term, Discocystis, with the same intent.

Thus three different generic names have been introduced for three very dubious specimens of agelacrinites, of which two doubtless belong to the same species and of all three of which very little has been known. No wonder that the eminent English echinodermist, Dr Bather, in a late work should indicate a sluggish receptivity for these names.[4]

This is the nomenclatorial history to the present of these peculiar bodies. Our new material from the Chemung sandstones enables us to carry it forward, and it is hoped at the same time to elucidate these polynomial structures.

The Chemung agelacrinite (A. alleganius), like all its later allies, was sessile but not fixed. No specimen has been seen

[1] North American geology and paleontology. 2d appendix, p. 744.
[2] Quar. jour. geol. soc. 1897. 53: 123–36.
[3] North American geology and paleontology. 2d appendix, p. 734.
[4] Lankester's Treatise on zoology. 1900. pt 3, p. 208.

attached to any other body, and yet all that have been found occur in clusters. The aboral surface is gently depressed, with large marginal plates projecting downward as a peripheral ring. On the oral surface the five ambulacra are extremely narrow, directed radially, and when near the periphery bend abruptly to the right (contrasolar) and are extended like whiplashes parallel to and very near the periphery, slightly undulating in their course. These narrow ambulacra are covered with very fine interlocking, triangular, arching cover plates. The thecal plates on both aboral and oral surfaces are imbricating or have that appearance.[1]

This organism resembles Agel. kaskaskiensis, Echin. sampsoni (Echinodiscus-Discocystis-Ageladiscus) and Lepidodiscus squamosus in the narrow, whiplike character of its rays. It differs from the two former (but not from Lepidodiscus) in the squamous aspect of the thecal plates and from all in the uniform contrasolar direction of all the rays.

We can not hope to arrive at a proper or approximate generic designation for this and related agelacrinites unless we undertake here to consider briefly what constitutes the values of certain morphologic features in this group of species.

Thecal plates. The earlier or Siluric agelacrinites have a squamous surface of imbricating plates; A. alleganius of the Chemung and the lower Carbonic A. squamosus and A. blairi have the same. The middle Devonic A. hamiltonensis has irregularly shaped mosaic thecal plates with sculptured and ridged surfaces, while the Carbonic species of the "Echinodiscus" group have smooth and regular polygonal mosaic plates.

In many species a circular wall bounding the apexes of the rays is built of large and strong plates supported on the periphery by much smaller plates (A. hamiltonensis) or

[1] It may be doubtful whether on the interradii and aboral surfaces these plates always actually overlap each other as they clearly do in the peripheral region. They have a scaly appearance which may be due to the greater thickening at the inner or proximal edges on both surfaces.

the larger plates may themselves be peripheral and project downward below the level of the aboral surface (A. alleganius) or all the marginal plates be of uniform and small size (A. cincinnatiensis), with the peripheral area outside the circular wall very broad (A. buttsi, A. legrandensis) or these plates be both large and small (A. dicksoni).

Agelacrinites holbrooki James of the upper Siluric has the interradial spaces paved with a mosaic of five and six sided plates, while the marginal plates are imbricating.[1] This condition, though pronounced in this species, is also apparent in less degree in all species with mosaic plates over the interradii. Such a combination of plating would seem essentially to neutralize the influence of the character of the thecal plates alone as a generic feature, when considered independently of other structure. It was the difference in this respect indicated by the first species above mentioned, together with a difference in the attitude of the rays, that furnished to Meek occasion for introducing his term, Lepidodiscus, for the squamous forms.

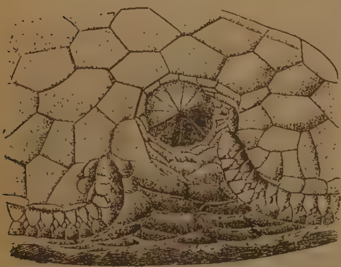


FIG. 2 A. holbrooki James. Anal region much enlarged, showing the mosaic plates of the interradii, the squamous plates of the margin, the crowding of small plates about the anal pyramid and the terminations of R 1 and 5. Between the cover plates of the latter will be observed minute accessory plates, two for each interval.

Madreporite. Dr Bather has indicated the presence of a madrepore in his copied figures of A. cincinnatiensis and A. hamiltonensis (*op. cit.* p. 205). I have, however, seen nothing in any agelacrinite that can be safely thus designated.

Rays. *Direction.* Of the species of "Agelacrinus", some of the early Siluric forms like A. billingsi Chapman of the Trenton and A. bohemicus Barr. (Étage D), have the rays sharp and quite straight, abutting against or tapering to a broad margin of larger and smaller plates. In others the rays are all solar, as in A. alleganius,

[1] Cin. soc. nat. hist. Jour. 1887. 10:25.

or all contrasolar, as in A. dicksoni Billings (Trenton). Four rays contrasolar and one solar is the usual expression, as shown by A. (Lepidodiscus) squamosus Meek and A. (Echinodiscus) kaskaskiensis Hall of the Keokuk and Chester groups of the lower Carbonic, A. cincinnatiensis Roemer, A. holbrooki and A. pileus Hall of the Cincinnatian group. In A. hamiltonensis Vanux. (middle Devonic) two are solar and three contrasolar. Even the number of the rays seems not to be always five, as Faber has described a species supposed to have seven rays, (A. septembrachiatus; Cincinnatian) and Miller and Gurley one with but four (A. legrandensis; Kinderhook).

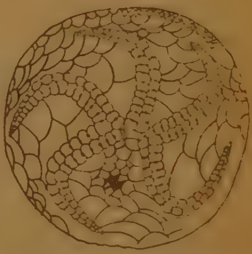


Fig. 3 A. dicksoni Billings x 1½ showing the five contrasolar rays and the ambulacral plates which were regarded as perforate by Billings (From Ottawa field nat. club. Trans. 2. 1881. plate fig. 9)

Young specimens of A. alleganius, A. buttsi and of the A. hamiltonensis show that the ambulacral rays in early growth extended in direct radial lines to the margin or elevated submarginal wall. They did not however pass on to the aboral surface, though in A. alleganius they reach the margin, but in the young of A. hamiltonensis and A. buttsi these rays abut directly against a highly developed ridge. The final course of the rays is then not determined except with the approach of mature conditions, but is nevertheless constant, and we have no record of any departure from the regularity and uniformity of their direction in a given species or homogeneous group of species.

This feature is notably one in which specific character is not expressed or suggested before the commencement of mature growth, and it seems therein to lose all value as a feature of higher (generic) distinction, though persistent as a specific character. The primitive direction of these rays is repeated in the adult expressions of the earlier agelacrinites, as cited above.

Size, length and structure. Among the Agelacrinitidae (re-

stricting the family by the limits drawn by Bather and Jaekel, and leaving out of present consideration the genus Edrioaster) it is a notable fact that the rays are broadest and shortest in the earlier species. This is very noticeable throughout the considerable array of Siluric species, A. billingsi, cincinnatiensis, holbrooki, dicksoni, etc. In the early and middle Devonic (A. hamiltonensis; A. rhenanus, upper lower Devonic, Unkel, Rhine) the rays have become slender and very long, but the most extreme expressions of these characters are to be seen in the species of still later age. It naturally ensues from this narrowing of the ambulacra that the composition of these areas with the usual preservation of the fossils becomes much obscured in later forms. Billings claimed that in the Trenton species A. dicksoni, perforated ambulacral plates were exposed, but this observation has not been confirmed and Jaekel holds that no ambulacral plates were present in these bodies. At all events usually only the cover plates have been observed. The later whiplash rayed species A. alleganius, A. beecheri, A. lebouri, A. (Echinodiscus) kaskaskiensis, A. (E.) sampsoni, A. (Lepidodiscus) squamosus, show only rows of small, arched, angular cover plates more or less completely interlocking at their edges.

Mouth and oral plates. The oral aperture is somewhat elongated in all forms of true Agelacrinites, and in some it has been represented as covered with a few large oral plates. This structure has, however, seldom been clearly made out except for some of the Siluric species. In A. hamiltonensis, as shown in the accompanying figure of the type specimen (pl. 10, fig. 6) it is somewhat schematic. Meek, on the other hand, represents the oral region of A. squamosus as covered by a multitude of minute plates, but as no special mention is made of the oral structure in his description, I infer that this also is somewhat restored. In his description of Echinodiscus and E. optatus, Miller makes special mention of the fact that the rays do not depart from a central point, but that this point of departure (oral opening) is elongated, two rays

departing from each extremity and the fifth from the side. This is a condition which is common to most true agelacrinites, but it is very much more pronounced in all postsiluric species, being no doubt emphasized in expression by the more slender rays.

Anal pyramid. The valved anal aperture may be situated centrally or laterally in an interradius. It is interesting to note that, whenever a reversal is present among the rays, it invariably affects that adjoining this aperture, so that the pyramid lies in a subcircular interradius bounded by the concave curves of neighboring rays, as though indeed the function of alimentation were conserved by this close approach of the ambulacra.

Mode of growth. These bodies divide themselves into species which grew attached to other bodies and those which may have rested on other surfaces and so have taken a flattened form but were not permanently fixed. To the former, apparently, belong all or nearly all of the earlier species as well as the Devonic Agelacrinites hamiltonensis, the supradevonic A. buttsi and A. legrandensis. So far as the evidence goes, A. alleganius, A. kaskaskiensis (A. optatus), A. sampsoni, A. squamosus, A. beecheri, all late species, were not attached, even in pretty early growth stages. Thus, while fixation continued throughout the history of the group as a species character, freedom from fixation pertained almost wholly to the latest representatives, save in cases where notable degeneration had set in. Such permanently attached species as pass beyond Devonic time are also marked by the persistence of a primitive expression in other respects, in size, shortness and directness of arm, and breadth and composition of the marginal border.

Summary. It appears from the foregoing that we may leave out of consideration as a generic character of the agelacrinites the variation in the direction of the rays and may consider as structures of convenient generic value 1) the character of the thecal plates, whether *a*) squamous or *b*) mosaic, and if the latter, whether *1*) polygonal and smooth or, *2*) irregular and sculptured; 2) the character of the rays, whether *a*) long and whiplash

shaped, with narrow, arched cover plates or *b*) shorter and broader, with broad and long cover plates; 3) the presence and structure of a peripheral band either *a*) composed of few large plates with very fine ones on the outer edge or *b*) broad with a great number of small plates.

So far as the generic names actually proposed are concerned, they are found to embrace the before mentioned characters in the following manner.

Agelacrinites: *thecal plates* mosaic, irregular, sculptured
rays very long and narrow
peripheral band composed of large plates with very small ones at the margin
A. hamiltonensis Vanux.

Discocystis (=Echinodiscus=Ageladiscus): *thecal plates* mosaic, polygonal, smooth
rays very long and narrow
peripheral band composed of a few large plates with no fine ones outside of them
D. kaskaskiensis Hall
D. sampsoni Miller

Lepidodiscus: *thecal plates* squamous
rays very long and narrow
peripheral band very narrow or extinguished, composed of large and small plates; the latter few, the former projecting on the aboral surface
L. squamosus Meek
L. alleganius sp. nov.

These generic names strictly construed, as they must be to maintain a definite value, leave a commanding number of agelacrinites without farther appellation. We do not zealously contend for the value of such divisions among these later Agelacrinites. If any fact is made clear by the foregoing observations it is that passage conditions from one to another of the typical species of proposed genera of these bodies do exist in such measure as to obscure the validity of the divisions. Nevertheless such terms may be used helpfully till our knowledge

affords a better basis for interpreting the affinities of these organisms. Both convenience and necessity seem to require the continued employment for the present of the term Agelacrinites in a broad sense for such species as have not been or can not yet be subjected to close analysis, but in such a case the name should, I believe, be used with full admission of the fact that it is merely a term of convenience and not to be confounded with the strictly defined genus Agelacrinites.

Lepidodiscus alleganius *sp. nov.*

Pl. 10, fig. 1–5

Disks compressed, with gently convex upper, and somewhat concave lower surface; sessile but not firmly attached or cemented.

Oral surface. Rays five, all contrasolar; very narrow, direct or gently sinuous near their origin for about half their length; then bending more or less abruptly, the extremital part running close within or subparallel to the margin and varying in its curvature, assuming the aspect of a whiplash. Oral aperture elongate, and from each extremity arise two of the rays, the fifth departing from the middle of the upper edge and lying opposite the anal pyramid. In all observed specimens the ambulacral plates are concealed by the rows of cover plates with their convex interlocking edges represented by a fine, serrated median line on all rays; this line also extends over the oral area. Anal pyramid circular, composed of 10 triangular plates.

Thecal plates on interradii imbricating, with no difference apparent in the plating of the anal interradius. The imbrication is in all cases directed centripetally or toward the mouth. Marginal plates not noticeably larger or more prominent on this surface.

Aboral surface. Depressed, with projecting periphery composed of more prominent plates. General surface with imbricating plates clearly shown. Here, however, the direction of the imbrication is centrifugal or away from the center of the disk and is thus continuous in direction with the imbrication of the upper or oral surface.

Young stages. In the earliest growth observed the rays are direct and pass to the margins without curvature, ending there so abruptly as to convey the impression that they extend over the margin to the lower surface. In the young example figured the rays are still direct, but show a gently undulating course to the margin. The aboral surface of none of these young forms has been seen. Many examples of this species and all the young specimens are casts of the exterior. Some of the young examples present rays which are but very slightly elevated along the cover plates and have deeply impressed and broad marginal furrows.

Dimensions. Adult specimens have a diameter of from 35 to 50 mm, and the smallest observed is 13 mm in diameter.

Geologic horizon and localities. In the Chemung sandstones at and near Alfred, Belvidere and Wellsville N. Y., and 2 miles south of Sabinsville, Tioga co. Pa.

Agelacrinites beecheri *sp. nov.*

Fig. 4–6

Body of medium size, sessile, but not permanently attached; highly convex on the oral surface with steep marginal slopes. Aboral surface flat or concave.

Thecal plates squamous, imbricating and conspicuous over the interradii. Marginal plates just outside of the arms irregularly elongate but not much larger than those of the interradii. Outside of this is a wall of numerous small and acute peripheral plates.

FIGS. 4–6 A. beecheri, natural size. FIG. 4 is from an internal cast of the oral surface, shows the direction of the rays but is defaced about the oral aperture. FIG. 5 is a fragment showing R 3, 4, 5 and the narrow oral aperture. FIG. 6 is an enlarged sketch of the subambulacral plates drawn from a squeeze of fig. 4.

Rays 5, departing from a deeply quinquepartite and hence small and narrow, oral depression; flagellate, 4 contrasolar, 1 solar, the latter adjacent to the anal pyramid with which it is approximate.

Radial cover plates triangular and interlocking along the median line. At the base the ambulacra have a pavement con-

sisting of a single series of squamous plates overlapping distally along the length of the arm; each of these plates is sharply depressed at the side to form two deep pits corresponding to elevations on the marginal plates.

Horizon and locality. Lower Carbonic below the horizon of the Olean conglomerate at Warren Pa.

Observations. The specimens on which this description is based were collected by Prof. C. E. Beecher and are in the Yale museum. The best of the examples comprises internal and external casts of the body, the parts about the oral aperture being defaced. This specimen is specially interesting in affording evidence of the subambulacral plates. So far as known but two instances have passed on record of specimens in which the structure of these plates is shown, one a specimen of A. cincinnatiensis described by Meek, and the other the original specimen of Roemer's genus Haplocystites from the lower Devonic of the Rhine. Both of these instances are cited by Jaekel, who has given a new illustration of Haplocystites rhenana. It does not however appear from either of the instances cited that the pavement plates actually overlap each other as shown by this specimen of A. beecheri.

In size and many of its structural features A. beecheri is similar to A. lebouri Sladen from the lower Coal Measures of Waterhead, Cumberland (*see* for corrected figures Jaekel, *Stammesgeschichte der Pelmatozoen*, pl. 1, fig. 7).

Agelacrinites buttsi *sp. nov.*

Pl. 10, fig. 7–9

Disks small, cemented by the aboral surface. Oral surface convex medially, with very broad and flat marginal rim, sharply elevated on its inner edge and composed of minute imbricating plates. Rays five, four of which are solar, R 5 being contrasolar and facing R 1. These are narrow, extend to the edge of the border, their extremities curving close within this edge. Interradii composed of imbricating plates. Anal pyramid small and

well defined. In young stages the oral surface is much contracted, the marginal rim proportionally broader, and the rays are straight, passing directly to the elevated inner edge of the rim.

Nine of these individuals have been found attached to a fragment of a shell of Ptychopteria.

FIG. 7 A. buttsi, natural size. Lower Carbonic, Warren Pa.

Geologic horizon and localities. Specimens of various sizes have been found on the southwest slope of Mt Moriah about 1½ miles south of Russell station, Cattaraugus co. The horizon is regarded as above the range of the true Chemung fauna. It is about 100 to 150 feet above the Wolf creek conglomerate, lying between the latter and the Mt Hermon sandstone.

In the succession of faunas from below upward in this section, a marked change occurs at the Wolf creek conglomerate, notable both for the introduction of species having a postdevonic aspect and for the extinction of typical Chemung forms. Thus appears here a species of Oehlertella closely similar to O. pleurites, of the Ohio Waverly; all the Productellas have disappeared; Leptodesma potens, mortoni, sociale do not pass above this horizon; L. curvatum, maclurei, mytiliforme, orodes, etc. appear only above it. Likewise the Pararcas (3 species), the Ptychopterias for the most part (8 species), the Palanatinas (2 species) lie above it; the dictyosponges all lie below it.

A close analysis of the new elements introduced here shows various early Carbonic affinities, and none perhaps more emphatically than this species itself, A. buttsi. The expression of this fossil is primitive throughout and indicates the senile manifestations of race exhaustion. The species has also been found by Prof. Beecher at about the same horizon in the section at Warren Pa. Of similar structure and diminutive form are certain other agelacrinites described from the lower Carbonic, A. legrandensis Miller & Gurley, Kinderhook, A. blairi Miller, etc.

It would appear that the final stages of the development of the agelacrinites had taken diverse courses, one through Agelacrinites into the Lepidodiscus-Discocystis line to extinction (L. alleganius, D. kaskaskiensis, L. squamosus), the other into the expression of Agelacrinus buttsi, blairi, etc. which bear the stamp of the initiatory phases of the race.

Various writers have been disposed to separate the agelacrinites from the Cystidea, Billings having first introduced a distinctive name for the entire group, Edrioasteroidea. Jaekel proposed (1895) to term essentially the same group, Thecoidea. Of the subdivisions of this class the family Agelacrinitidae is well defined, though its members and their genetic relations are still promising subjects for study.

VALUE OF AMNIGENIA AS AN INDICATOR OF FRESH-WATER DEPOSITS

DURING THE

DEVONIC OF NEW YORK, IRELAND AND THE RHINELAND

BY JOHN M. CLARKE

Pl. 11

In 1842 Vanuxem described, from Mount Upton N. Y., as C y p r i c a r d i t e s c a t s k i l l e n s i s and C. a n g u s t a t a, certain fossil clams, for which Hall at a later date erected the generic term Amnigenia, including both forms under the single name A. c a t s k i l l e n s i s. Neither Vanuxem nor Hall ventured to suggest that this organism was closely related to the existing fresh-water clams Anodonta or Unio, but this proposition has at various times been made without close analysis of its probabilities; more recently, however, it has been carefully discussed by Beushausen.[1]

The exterior resemblance of this mollusk to Anodonta is certainly most striking, but this fact contributes less to the indication of its fresh-water habit than the conditions under which its involving sediments were laid down. This clam has been found not only at Mount Upton, the original locality, but also, according to Prof. Hall, at "Gilbertsville, Otsego co.; on the road from Jefferson to Gilboa, and at the base of the hills to the south of Jefferson, Schoharie co. N. Y. Prof. J. J. Stevenson has found a single valve of this fossil in the Catskill red sandstone on Wills creek, about 1 mile from Hyndman, and 1600 feet above the base of the formation, in Bedford co. Pa." More recently it has been found in quantity and well preserved at Oxford, Chenango co. in the quarries of the F. G. Clarke bluestone co. Its occurrence in New York is, so far as known, restricted to the Oneonta sandstone, the origin and stratigraphic

[1] Jahrb. d. königl. preuss. geol. Landesanstalt für 1890. separat p. 1–10, 1891.

relations of which have been a fruitful theme of discussion. The evidence now seems fully to justify the interpretation of this deposit as a sediment accumulated in nearly or quite impounded fresh water or of brackish water cut off from the open sea on the west by a low, shifting submarine bank, not well defined in the stratigraphy save that outside of it flourished a profuse marine fauna; and on the east continuous with and marking the inception of the Catskill sedimentation. During the period of the existence of these Oneonta beds but few instances appear of incursions from deeper waters. Yet such are not absent. The washing in from the deep water of flotillas of Orthoceras which were apparently killed by contact with the fresh water and are preserved in myriads erect in certain of the strata, has been recorded by the writer as evidence of the instability of the outward boundaries of the catchment basin. Other than this these sediments are not known to contain marine fossils. The fishes, Bothriolepis, Coccosteus, Holoptychius, etc. which appear with more or less frequency, have not been regarded as of true marine habit; on the contrary, their allies in the Old Red sandstone of Scotland and Russia are distinctive features of the lakes of that time. There are evidences of ostracodes and worm trails over the sandy bottoms, but most abundant of all forms of life are the accumulated fragments and trunks of Psaronius, Lepidodendron, Archaeopteris, and other plant remains.

There are other species of Amnigenia occurring in the Devonic, and these serve to strengthen very substantially the deductions made possible by the New York form.

Forbes long ago described[1] as Anodonta jukesi, a shell from Kiltorcan, Ireland. Beushausen, who has recently studied specimens of this fossil in the collections of the Landesanstalt at Berlin, ascribes it to Amnigenia, and notes its occurrence in sandstone beds associated with conglomerates and variegated shales underlying the Coal Measures. With regard to these Kiltorcan beds Sir A. Geikie has written as follows[2]:

[1] Geol. sur. Ireland. Mem. expl. sheets 147-57, p. 16, fig. 3a, b.

[2] Textbook of geology. 1893. p. 802.

The Old Red sandstone attains a great development in the south and southwest of Ireland. The thick "Dingle beds" and "Glengariff grits" pass down into Upper Silurian strata, and no doubt represent the Lower Old Red sandstones which cover them unconformably and resemble the ordinary Upper Old Red sandstone of Scotland. In Cork and the southeast of Ireland they are followed by the pale sandstones and shaly flagstones known as the "Kiltorcan beds", with apparently a perfect conformability. The Kiltorcan beds (which pass up conformably into the Carboniferous slate) have yielded a few fishes (Bothriolepsis, Coccosteus, Pterichthys, Glyptolepis), some crustaceans (Belinurus, Pterygotus), a fresh-water lamellibranch (Anodonta jukesi), and a number of ferns and other land plants (Palaeopteris, Sphenopteris, Sagenaria (Cyclostigma), Knorria).

The occurrence of A. jukesi is thus parallel in character and age to that of A. catskillensis.

Beushausen describes[1] as Amnigenia rhenana, a shell of about the size and proportions of A. catskillensis from various localities in the vicinity of Gräfrath in the Rhine province. The precise stratigraphic position of this species is not clearly established by the author cited, but from collateral evidence is regarded as probably of late middle Devonic age. The only fossils associated with it in the sandstone beds where it occurs are fragments of plants which are scarcely capable of identification. "This association with plant remains, as well as the character of the whole succession of sediments, doubtless indicates a near coast line, and one will not go far astray in concluding from the contemporaneous absence of all traces of a marine fauna, that these sediments are probably brackish water deposits".[2]

The Oneonta-Catskill sedimentation in its fullest development doubtless represents time from at least the close of the Hamilton stage. Prof. Hall was disposed in some of his writings[3] to regard the upper part of the Hamilton series of strata, as developed in central New York, as replaced eastward by the Oneonta beds. Present evidence may not fully corroborate this interpretation,

[1] Jahrb. d. könig. preuss. geol. Landesanstalt für 1890. separat p. 1–10, 1891.

[2] *Idem.* p. 2.

[3] *See specially* Pal. N. Y. v. 5, pt 1, 2, p. 517.

but it is however quite clear that the change in local conditions initiating this deposit of estuarine or fresh-water sediments manifested itself at a continually earlier period of the Devonic, as one proceeds eastward from central New York toward the Hudson river.

The three known occurrences of Amnigenia; A. catskillensis in New York and Pennsylvania, A. jukesi in Ireland and (according to Frech) in Devonshire, and A. rhenana in the Rhineland, are thus alike in the nature of the involving sediment, viz sandstones and sandy shales bearing terrestrial plant remains, but with a total absence of marine organisms; and are essentially equivalent in age, marking only different stages or levels during the continuance of Old Red sedimentation.

We have observed that data of this kind are stronger evidence of the fresh-water habit of this clam than any that can be derived from the structural characters of the fossils themselves in their present preservation. There is however in all a strong Anodonta or Unio aspect. As the hinge in these genera is normally but slightly diversified, little but negative evidence is to be expected from the fossils. The absence of hinge structures in all these cases is such evidence of much weight wherein we may find indication of close conformity in structure. Beushausen is disposed to caution in inferring, in the absence of more positive indications, immediate relationship to Unio or Anodonta, and concludes that, "though Amnigenia may be regarded as the forerunner of the recent Unios, one will do well not to infer a direct phylogenetic connection by the employment of the term Anodonta, for which all proof fails" (p. 8). We figure here a slab of Oneonta sandstone from the Clarke quarry at Oxford, which bears 30 shells of A. catskillensis on a surface 14 by 10 inches. Some of these shells have apparently been drifted into their places, but several present the appearance and attitude of shells which had been boring in the mud. The valves are all double and closed, so that they must have been buried fast in the sediment while alive or before

decomposition relaxed the adductor muscles sufficiently to permit the valves to gape. All lie at an oblique angle across the lines of sedimentation and seem to have been exposed just as they died and were buried in their holes or washed into the mud at the bottom of the coastal lake. This specimen has been presented to the museum by E. E. Davis esq. of Norwich N. Y.

EXPLANATION OF PLATES

All specimens figured on plates 1–7 are from the lower Trenton conglomerate of Rysedorph hill, Rensselaer co. N. Y., if not otherwise stated.

PLATE 1

(All originals in state museum)

Bolboporites americanus Billings

p. 11

Fig.

1 A somewhat weathered specimen. x 3

Pebble of group 3

Stomatopora inflata Hall *sp.*

p. 12

2 A somewhat turgid variety. x 10

3 A normal form. x 10

Pebbles of group 5

Siphonotreta minnesotensis Hall & Clarke

p. 14

4 A pedicle valve. x 4

5 Lateral view of same. x 4

Pebble of group 5

Plectambonites sericeus Sowerby *var.* asper James

p. 18

6 An adult specimen, showing well developed cardinal corrugations. x 2

7 A younger specimen with still stronger corrugations. x 2

Pebbles of groups 6 and 7

Plectambonites pisum *sp. nov.*

p. 19

8 A pedicle valve with relatively long cardinal line. x 2

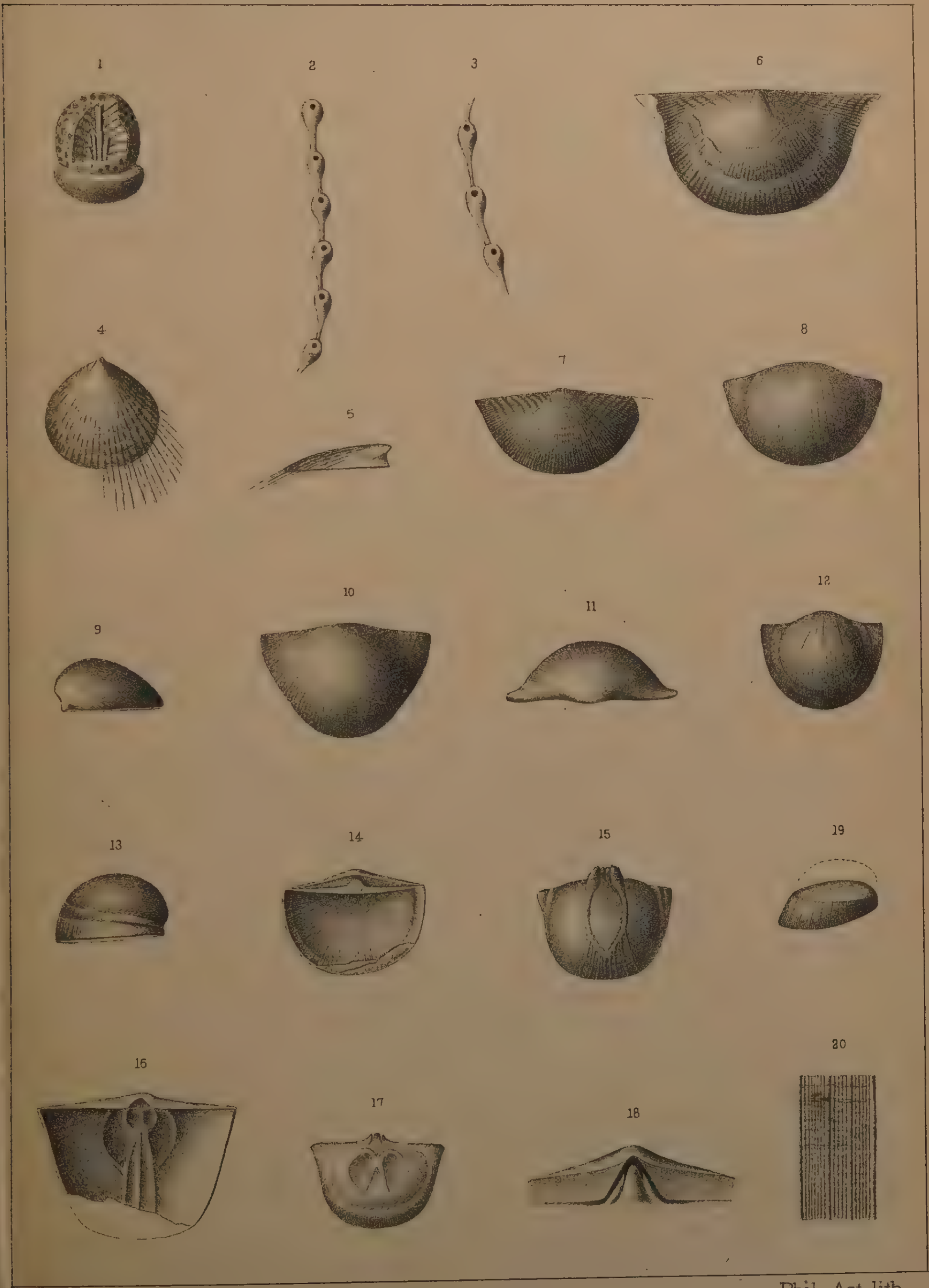
9 Lateral view of same. x 2

10 A less tumid pedicle valve. x 2

11 Posterior view of same. x 2

12 Pedicle valve of normal dimensions. x 2

RYSEDORPH HILL FOSSILS



G. B. Simpson del.

James B. Lyon. State Printer.

Phil. Ast, lith.

Fig.

13 Lateral view of same. x 2

14 Brachial valve. x 2

15 Internal cast of pedicle valve showing casts of muscular and vascular impressions. x 2

16 Interior view of pedicle valve showing muscle impressions and vascular trunks. x 2

17 Interior view of brachial valve. x 2

18 Cardinal process and crural plates. x 2

19 Broken shell showing the geniculate character of the posterior and lateral margins. x 2

20 Enlargement of surface. x 5

Pebbles of group 5

PLATE 2

(All originals in state museum)

Rafinesquina alternata Emmons *sp.*

p. 16

Fig.

1 One of the specimens of large size and strong cardinal extensions occurring in pebbles of group 7. Natural size

Christiania trentonensis *sp. nov.*

p. 21

2 Pedicle valve, somewhat exfoliated. x 2

3 Lateral view of same. x 2

4 Brachial valve. x 2

5 The interior of a brachial valve showing the quadruple adductor scar divided by high, vertical, muscular walls. x 2

6 Further enlargement of the cardinal region of the same showing the bilobed cardinal process and the denticulations on either side of the latter

Pebbles of group 5

Liospira americana Billings *sp.*

p. 31

7 Section natural size

Pebble of group 5

Cyrtospira attenuata *sp. nov.*

p. 35

8 Dorsal view. x 2

Pebble of group 7

Eccyliopterus spiralis *sp. nov.*

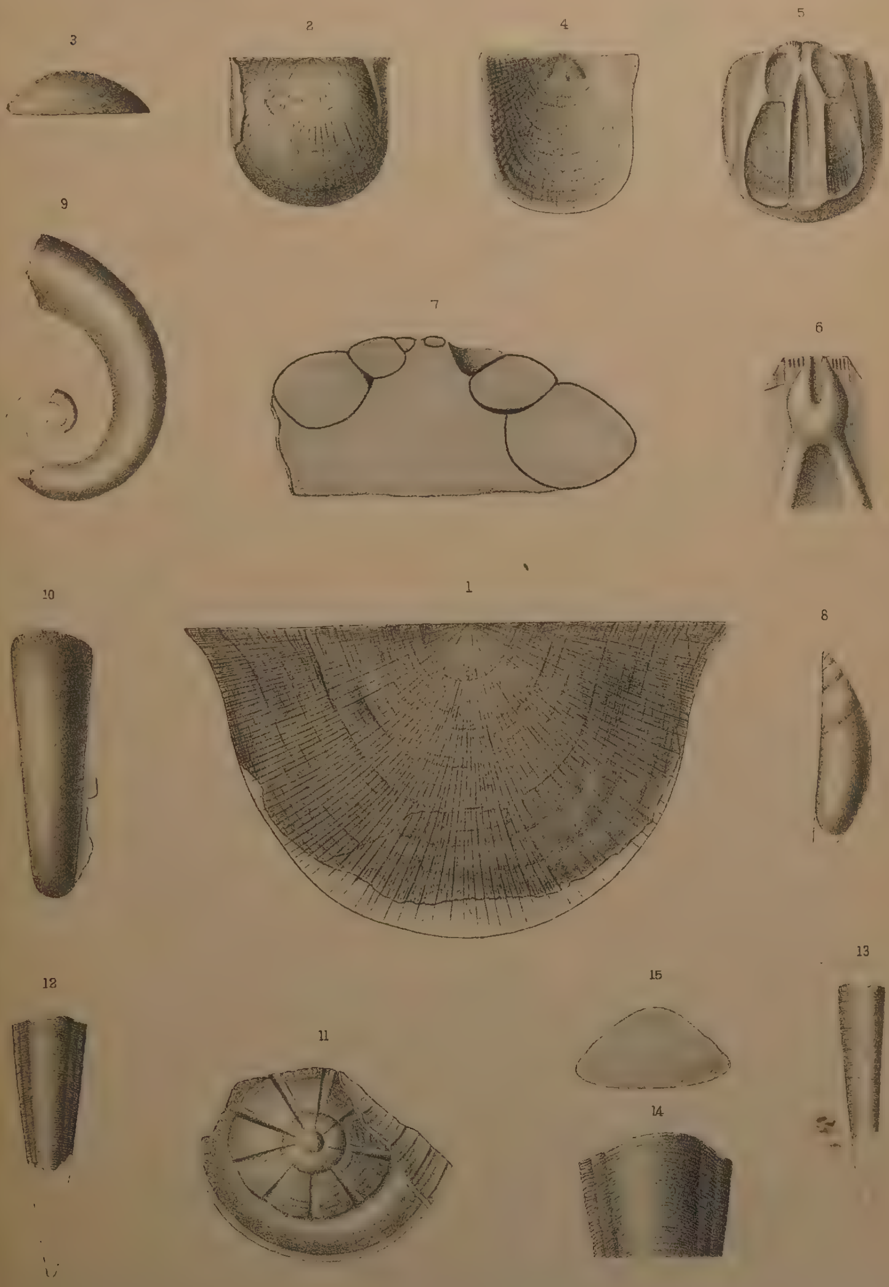
p. 34

9 Upper side of specimen. Natural size

10 Lateral view of same showing a portion of the collarlike upper carina. Natural size

Pebbles of group 5

RYSEDORPH HILL FOSSILS



G. B. Simpson del. James B. Lyon, State Printer Phil. Ast, lith.

Hyolithellus micans Billings

p. 38

Fig.

11 Internal cast of operculum. x 20
Pebble of group 1

Hyolithus rhine *sp. nov.*

p. 36

12 Dorsal view of specimen. Natural size
13 Lateral view of same. Natural size
14 Enlargement of distal part of upper side. x 2
15 Section of shell. x 2
Pebble of group 6

PLATE 3

(All originals in state museum)

Ampyx (Lonchodomas) hastatus *sp. nov.*

p. 48

Fig.

1 Pebble with cranidium of this species and stipe of Climacograptus scharenbergi. x 2

2 Cranidium of mature specimen viewed obliquely to show the glabella. x 2

3 Dorsal view of same. x 2

4 Lateral view of same. x 2

5 Cranidium of a younger specimen. x 3

6 Cranidium of the youngest specimen observed. x 2

7 Cast of the posterior part of the glabella showing two transverse, elliptic projections

8, 9 Two specimens retaining part of the rostrum, which in both is bent upward and in the latter also backward. x 2

10 Pygidium of a small specimen showing a pronounced median protuberance of the axis. x 5

30 Fragments of a partly decorticated pygidium showing the muscular impressions. x 5

Pebbles of groups 5 and 6

Tretaspis diademata *sp. nov.*

p. 46

12 Frontal view of cranidium. x 2

13 Dorsal view of same; posterior parts of glabella and cheeks not as well preserved as indicated by the drawing. x 2

14 Lateral view of same. x 2

Pebble of group 5

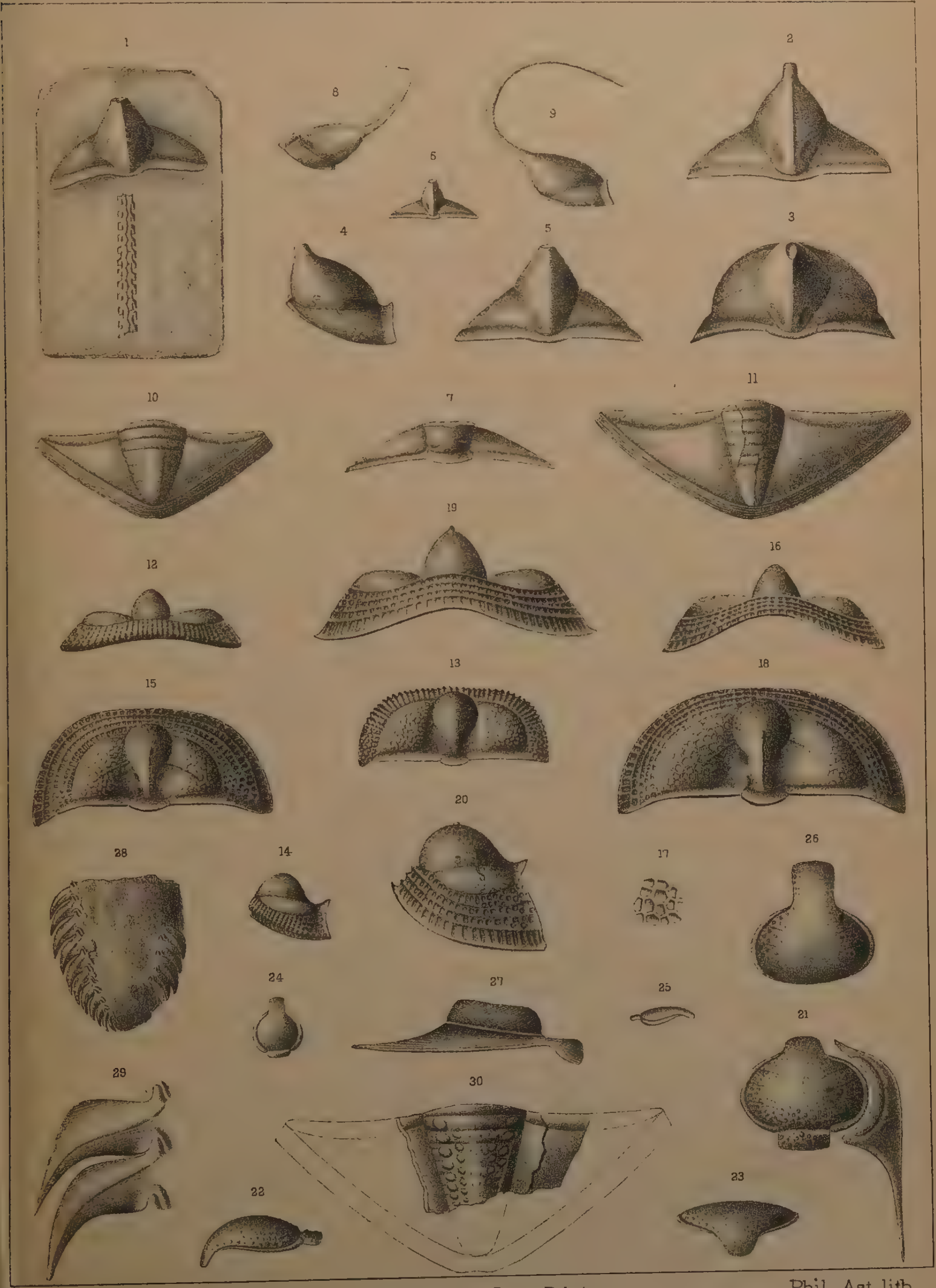
Tretaspis reticulata *sp. nov.*

p. 41

11 Pygidum. x 3

15 Cranidium of an adolescent specimen, showing the eye-lines, eye-tubercle and tubercle and crest on glabella. x 3

Bull. 49 N.Y. State Museum Plate 3



G. B. Simpson del. James B. Lyon. State Printer Phil. Ast, lith.

Fig.

16 Frontal view of same. x 3

17 Enlargement of reticulate surface. x 6

18 Cranidium of a supposedly mature specimen, showing similar features. x 3

19 Frontal view of same. x 3

20 Lateral view of same. x 3

Pebbles of group 5

Remopleurides (Caphyra) linguatus *sp. nov.*

p. 56

21 Dorsal view of cranidium and right free cheek. The shading represents the glabella as too convex. (Compare fig. 23) The free cheek was not found in the position figured. x 3

22 Lateral view of same. x 3

23 Frontal view of same. x 3

24 Cranidium of the smallest specimen observed. x 4

25 Lateral view of same. x 4

26 Cranidium figured in a position to show the length and form of the tonguelike process of the frontal lobe. x 4

27 Lateral view of free cheek, showing the delicate faceting of the eyes, and the rudderlike frontal doublure. x 5

28 Thorax, the central part destroyed by weathering. x 2

29 Enlargement of the pleurae, to show the fulcral tubercles. x 5

Pebbles of groups 5–7

PLATE 4

(All originals in state museum unless otherwise stated)

Isotelus *cf.* **maximus Locke**

p. 59

Fig.

1 Pygidium of a very young example partly decorticated and showing muscular impressions. x 5

Pebble of group 7

Remopleurides tumidus *sp. nov.*

p. 54

2 Dorsal view of cranidium. x 2

3 Frontal view of same. x 2

4 Lateral view of same. x 2

Pebble of group 6

Cyphaspis matutina *sp. nov.*

p. 62

5 Dorsal view of the cranidium of a very young specimen. x 10

6 Lateral view of same. x 10

7 Cranidium of an older (mature?) specimen. x 5

Pebbles of group 5

Cyphaspis hudsonica *sp. nov.*

p. 64

8 The only cranidium found, which is slightly flattened or crushed, and the occipital ring missing. x 4

9 Lateral view of same. x 4

From the upper Utica shale of Green Island

Bronteus lunatus Billings

p. 65

10 Small cephalon. x 3

From pebble of group 5

11 Copy of Billings's original drawing of this form

Trenton limestone, Ottawa, Canada.

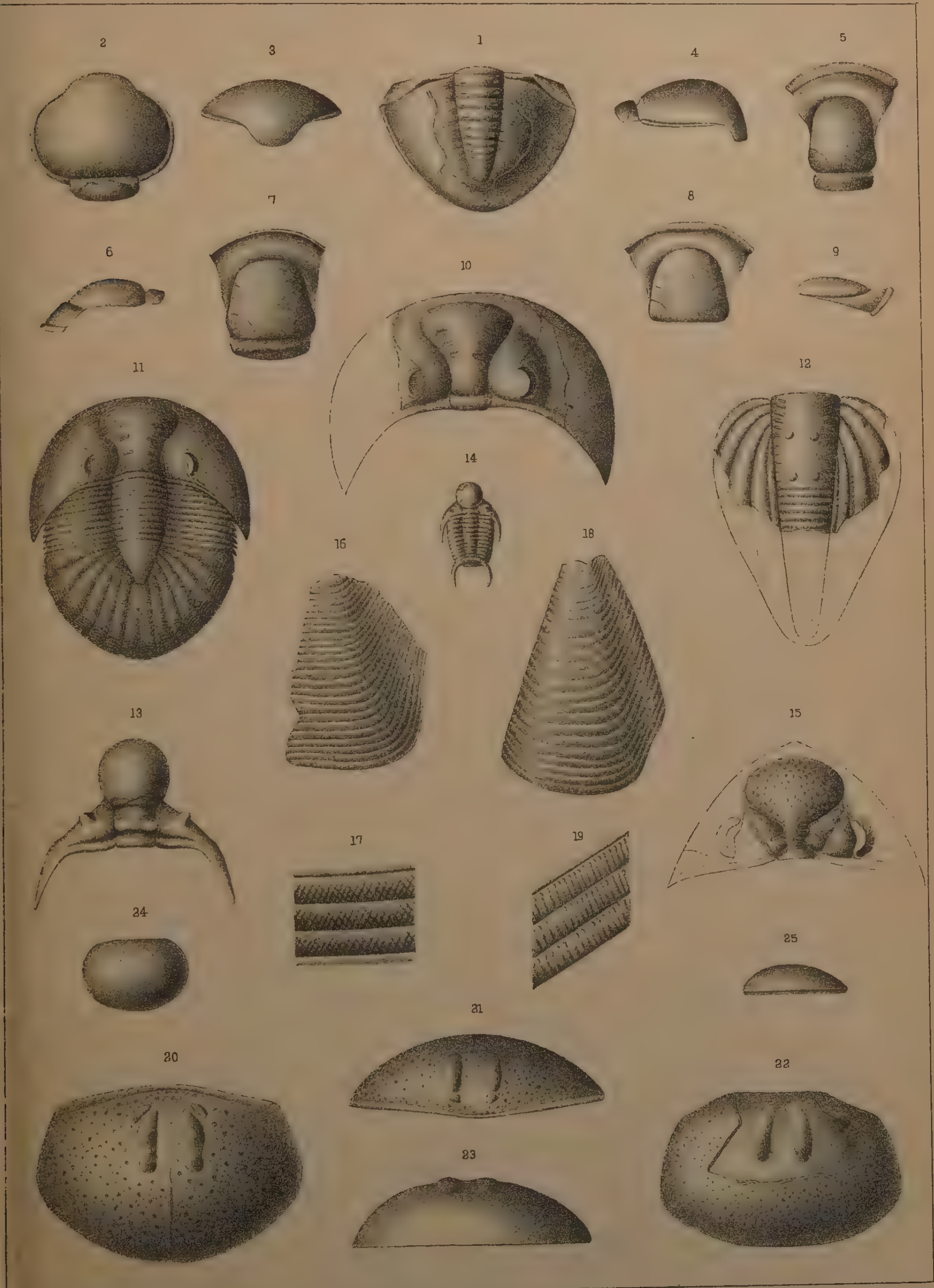
Cybele *sp.*

p. 66

12 Anterior part of a pygidium from a gutta-percha impression. x 5

Pebble of group 7

Bull. 49 N.Y. State Museum Plate 4



G. B. Simpson del. James B. Lyon. State Printer. Phil. Ast, lith.

Sphaerocoryphe major *sp. nov.*
p. 67

Fig.
13 Dorsal view of cranidium partly restored at the genal angles. Natural size
From a pebble of group 5
14 Copy of a mature specimen of Sphaerocoryphe robustus Walcott, in the state collection. Natural size

Pterygometopus eboraceus Clarke
p. 69

15 A cranidium. x 2
Pebble of group 7

Lepidocoleus jamesi Hall & Whitfield *sp.*
p. 87

16 A plate retaining the surface sculpture. x 10
17 The latter enlarged. x 25
18 Another plate where one of the two systems of striations is more strongly developed. x 10
19 Surface sculpture. x 25, showing the minute nodes appearing where the cross-striations intersect the transverse striae. The nodes are drawn a little too prominent.
Pebbles of group 5

Problematic crustacean

20, 21 Two views of the periderm of an organism which on account of the substance, general form and porosity of the shell probably belonged to the crustaceans. The symmetry of form shown in the outline of the shell and the position of the nodes would combat a reference of the form to the Ostracoda, which, at first glance, are suggested by the general form. It is possible that the specimens may be the head shields of a species belonging to the Merostomata. The description of the form is deferred till a fuller series of specimens has been obtained. x 10
22, 23 Two views of another, partly decorticated specimen, which show that the underside of the shell possesses depressions corresponding to the nodes. x 10
24, 25 Two views of a very small shell probably belonging to this organism, showing two faint symmetrically arranged nodes. x 10
Pebbles of group 7

PLATE 5

(All originals in state museum)

Eurychilina dianthus *sp. nov.*

p. 78

Fig.

1 A partly exfoliated right valve showing an elongate prominence on the internal cast. x 22

2 Another right valve retaining the granulose surface. x 22

8 The largest value observed; exhibits a faint, subcentral muscle impression. x 17

9 Frontal view of same. x 17

Pebbles of group 7

Eurychilina reticulata Ulrich

p. 76

3 A right valve, x 22, from a pebble of group 6

Eurychilina subradiata Ulrich *var.* **rensselaerica** *var. nov.*

p. 77

4 Left valve. x 22

5 Section of same across central portion of valve. x 22

6 Right valve. x 17

7 Right valve; frill partly broken away and showing the internal cast. x 17

13 Entire right valve showing pits on surface and radially striated border. x 22

Pebbles of groups 6 and 7

Eurychilina obliqua *sp. nov.*

p. 79

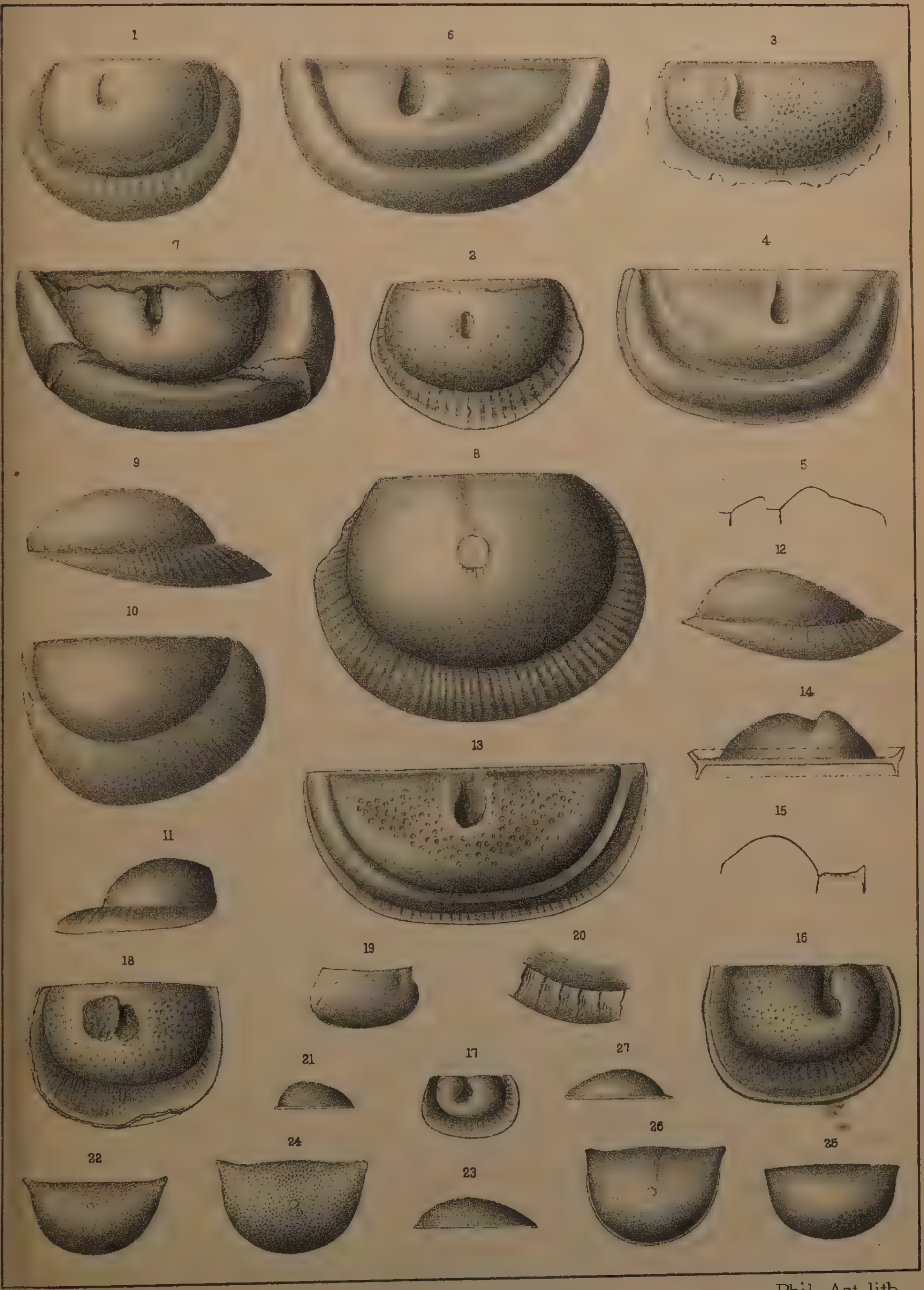
10 An entire right valve showing the broad, finely striated frill. x 14

11 Posterior view of same. x 14

12 Ventral view of same. x 14

Pebble of group 7

Bull. 49 N.Y. State Museum Plate 5



G. B. Simpson del. James B. Lyon. State Printer Phil. Ast. lith.

Eurychilina bulbifera *sp. nov.*

p. 76

Fig.

14–16 Ventral view, cross-section and lateral view of an entire left valve. x 22

17 A small right valve. x 22

Pebbles of groups 6 and 7

Eurychilina (?) solida *sp. nov.*

p. 77

18 Only valve found. x 22

Pebble of group 7

Leperditia fabulites Conrad *sp.*

p. 70

19 A right valve. Natural size

20 Enlargement of ventral border of same. x 10

Pebble of group 7

Leperditia resplendens *sp. nov.*

p. 71

21-23 Anterior, lateral and ventral views of a perfect right valve. x 17

24 Another right valve having the entire surface pitted. x 17

25 A valve in which only the ventral part shows a somewhat coarse pitting. x 17

26, 27 Lateral and posterior views of a valve which has the ventral region pitted. x 17

Pebbles of groups 6 and 7

PLATE 6

(All originals in state museum)

Bollia cornucopiae *sp. nov.*

p. 82

Fig.

1 Only valve found. x 22

2 Posterior view of same. x 22

Pebble of group 7

Macronotella fragaria *sp. nov.*

p. 85

3-5 Lateral, ventral and posterior views of a right valve. x 18

Pebble of group 7

Macronotella ulrichi *sp. nov.*

(*See* pl. 7, fig. 1)

p. 83

6-8 Three views of a coarsely pitted right valve with faintly indicated border. x 22

9 Lateral view of a right valve with distinct border and subcentral muscle impression. x 22

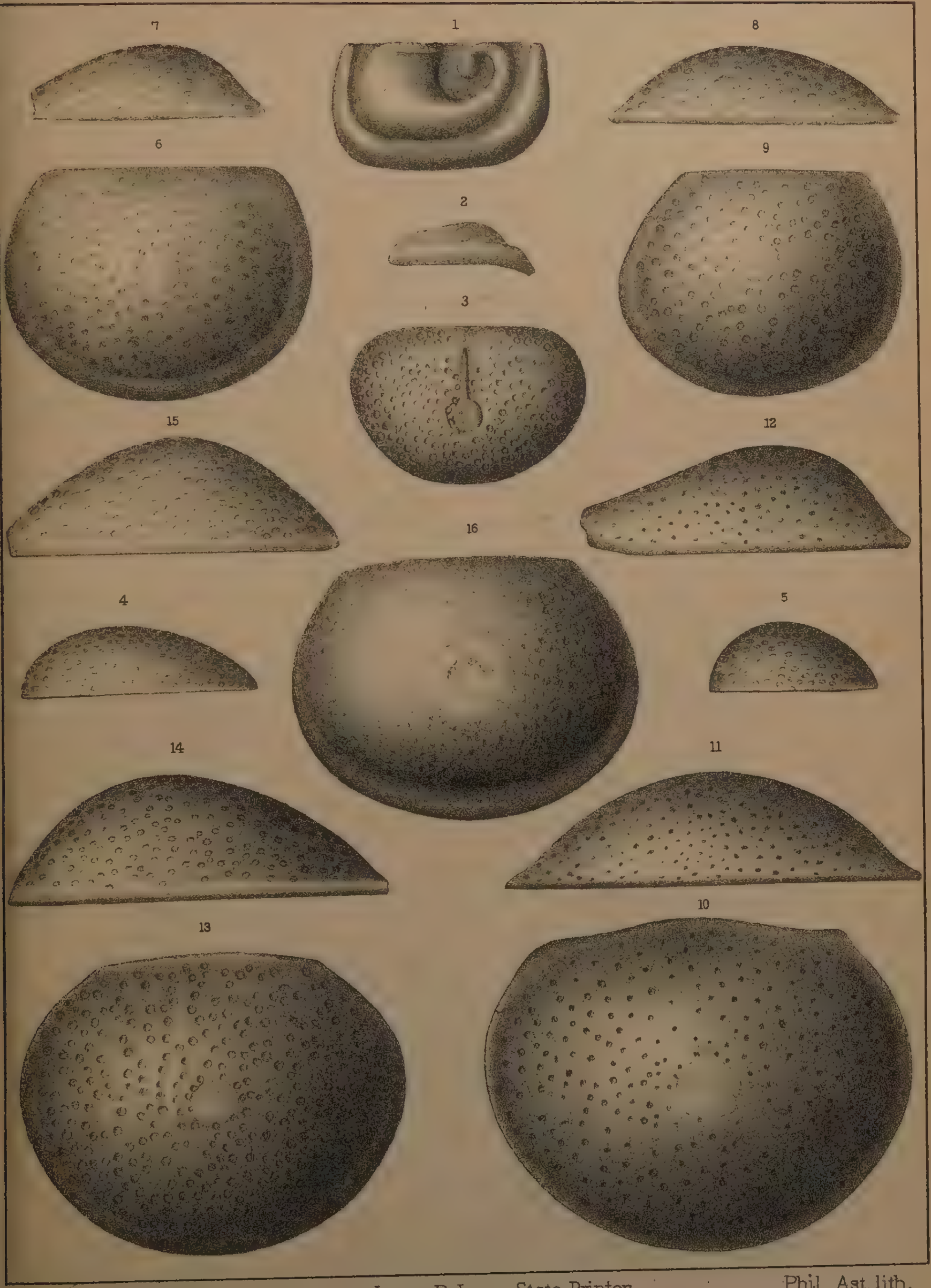
10-12 Lateral, ventral and anterior views of the largest valve observed. x 22

13-15 Lateral, ventral and anterior views of a right valve which shows all the characters of the species well developed. x 22

16 A more convex valve with less distinct pitting. x 22

Pebbles of group 7

 Plate 6



G. B. Simpson del. James B. Lyon. State Printer Phil. Ast, lith.

PLATE 7

(All originals in the state museum)

Macronotella ulrichi ***sp. nov.***

(*See* pl. 6, fig. 6-16)

p. 83

Fig.

1 Dorsal view of the valve represented in fig. 10-12 of pl. 6. The figure shows the reentrant cardinal area. x 22

Primitia mundula Miller *var.* **jonesi** ***var. nov.***

p. 80

2 Internal cast of a small valve showing a tubercle at the end of the sulcus. x 22

3 Right valve. x 22

4 Vertical view of same, showing the border. x 22

5 Another right valve in which the longitudinally arranged granules give the surface a striated appearance. x 22

Pebbles of groups 5 and 7

Aparchites minutissimus Hall *var.* **robustus** ***var. nov.***

p. 74

6-8 Lateral, anterior and ventral views of a right valve. x 17

9-11 Lateral, ventral and anterior views of the largest specimen observed. x 20

Pebbles of group 5

Schmidtella crassimarginata Ulrich, *var.* **ventrilabiata** ***var. nov.***

p. 75

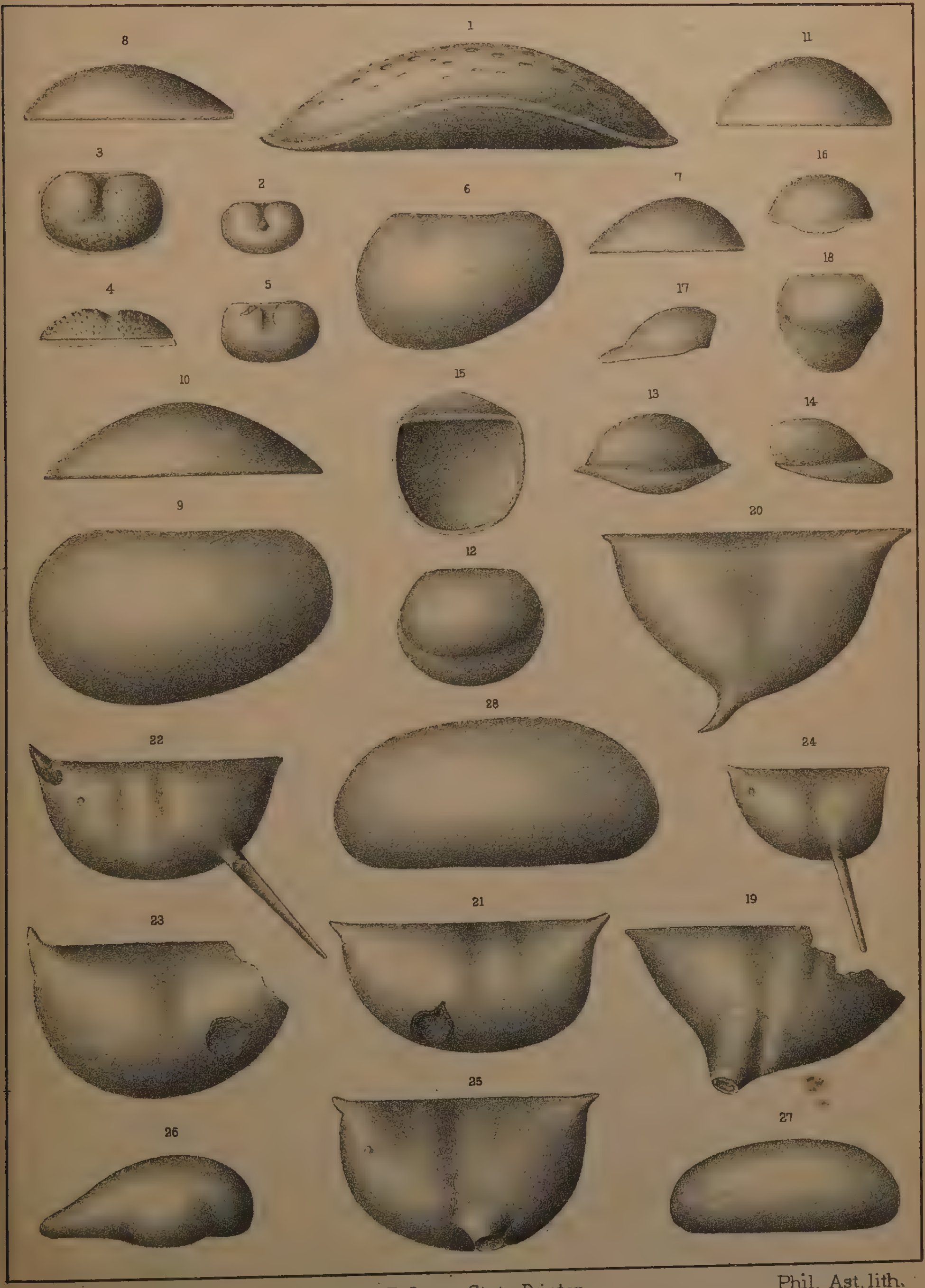
12-14 Lateral, ventral and posterior views of a left valve. x 22

15 Interior view of a valve showing the cardinal area. x 22

16-18 Ventral, terminal and lateral views of another left valve showing the ventral extension of the border. x 22

Pebbles of group 6

RYSEDORPH HILL FOSSILS



G.B. Simpson del.

James B. Lyon. State Printer

Phil. Ast, lith.

Isochilina armata Walcott *var.* **pygmaea** *var. nov.*

p. 72

Fig.

19 A somewhat fragmentary right valve showing a deep depression in front of the spine. x 22

20 A perfect right valve possessing a short unciform spine. x 22

21 A somewhat elongate right valve with distinct cardinal mucros. x 22

22 A small left valve possessing a long, straight spine and two faint depressions. x 22

23 A very obese left valve with very strong anterior mucro. x 22

24 The smallest valve observed; possesses long straight spine and distinct eye tubercle. x 22

25 A left valve with broad depression and eye tubercle. x 22

Pebbles of groups 5 and 6

Bythocypris cylindrica Hall *sp.*

p. 87

26 A left valve with a remarkable tumidity of the ventral region. x 22

27, 28 Two other specimens showing slight variations in outline from the average examples. x 22

Pebbles of groups 5-7

PLATE 8

(All originals in the state museum)

Thoracoceras wilsoni *sp. nov.*

p. 126

Fig.

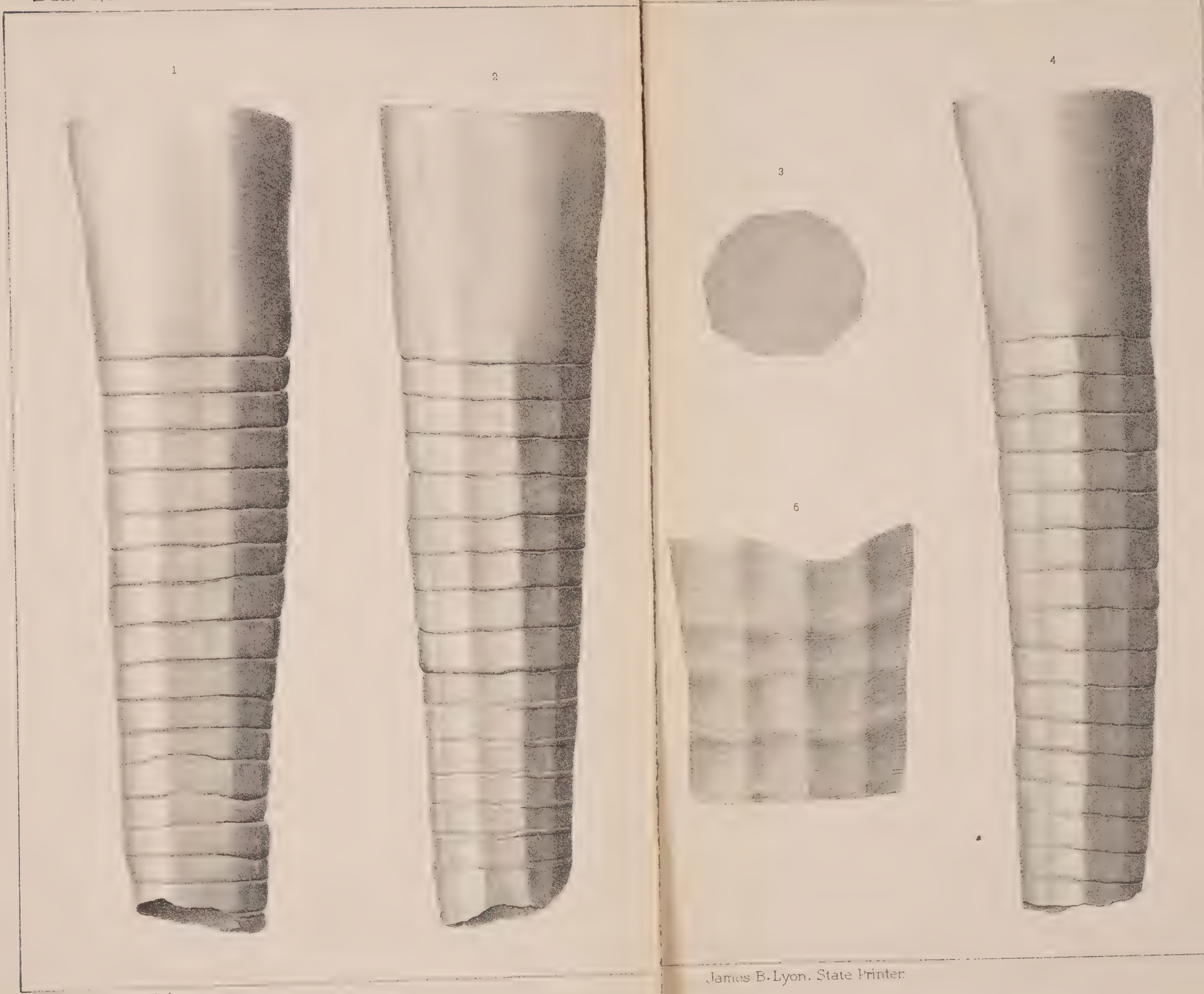
1-3 Three views of an internal cast; ventral, lateral and dorsal. This specimen retains the entire body chamber with aperture and 17 septa; shows the strongly prismatic sides which gradually become obscured over the body chamber, the broad inner flattening or impressed zone which is continued to the aperture, the gentle constriction of the body whorl and the lateral sinuosity of the aperture.

4 A cross-section of the same specimen showing the angularity of the septate portion, the relatively great breadth of the impressed zone and the gentle concavity of all the sides.

5 The exterior of a part of the body whorl of the same specimen from a gutta-percha squeeze, showing the sinuosity of the aperture, the continuation of both vertical and transverse ridges in an obscured condition with low nodes at their intersection over this surface, and in addition thereto the very fine concentric lineation of the shell.

6 The exterior of another specimen obtained by the removal of the shell from the matrix by calcination, the drawing being made from a gutta-percha squeeze. This covers mainly the septate part of the shell, shows the annuli and vertical ridges with their strongly nodose intersections. In other specimens these nodes are seen to be at times acute and spiniform. The specimen also shows the finer concentric lineation of the surface.

Agoniatites limestone. Manlius N. Y.



G.B. Simpson del.

James B. Lyon. State Printer

PLATE 9

(All originals in the state museum)

Crania recta *sp. nov.*

p. 157

Fig.

1 The upper valve with outlines of dorsoventral and lateral sections. x 3

2 Mold of upper valve, with portion of shell attached, showing muscular scars. x 3

3 View of another specimen similarly preserved

Chonetes scitulus Hall

p. 159

4 Pedicle valve of small specimen showing a faint sinus. x 2

5 A large pedicle valve. x 1

6 Section of above. x 1

Camarotoechia pauciplicata *sp. nov.*

p. 162

7–9 Dorsal, anterior and ventral views of a specimen from the Stafford limestone of Genesee county. All x 2

10 Pedicle valve of a specimen from which the beak has been broken. x 2

11 Lateral view of the same. x 2

12 Dorsal valve. x 2

Camarotoechia prolifica Hall (?)

p. 162

13 Dorsal view of a specimen with beak restored. x 2

14 Lateral view of the same. x 2

15 Ventral valve. x 2. The beak is restored from another specimen.

Leptodesma marcellense Hall

p. 167

16 Left valve of a small specimen which is somewhat less oblique than the typical form. x 3

17 Left valve of the normal form. x 3

STAFFORD LIMESTONE

E. Wood del. James B. Lyon. State Printer. Phil. Ast, lith.

Lunulicardium fragile Hall

p. 168

Fig.

18 A large left valve with an unusually broad anterior expansion. x 3

19 A similar specimen from the lower shale beds. x 3

Onychochilus (?) nitidulus Clarke ?

p. 170

20 A small exfoliated specimen. x 10

Ambocoelia nana Grabau

p. 165

21–23 Ventral, lateral and dorsal views showing the spinous surface, transverse form and small size compared with A. spinosa Clarke. x 3

All specimens are from the Stafford limestone of Lancaster N. Y. unless otherwise indicated.

PLATE 10

(All originals in state museum unless otherwise stated)

Lepidodiscus alleganius *sp. nov.*

p. 194

Fig.

1 A young individual, oral aspect. The rays are direct or but slightly undulating, reach the margin and terminate there if not extending somewhat on to the lower surface of the test. The structure of the rays and mouth is lost, but the former are seen to lie in well defined grooves. x $1\frac{1}{2}$

Chemung sandstones. Loose at Alfred N. Y.

2 The aboral aspect of a large individual, showing the depressed surface of imbricating plates directed centrifugally and the projecting margin of coarser plates. Normal size

Chemung sandstones. Loose at Belvidere N. Y.

3 Oral aspect of a mature individual, showing the extremely narrow undulating whiplash rays, all solar; the elongate oral aperture and mode of divergence of the rays therefrom; the fine interlocking line of the cover plates. Also the position of the anal pyramid and the absence of specially differentiated marginal plates. x $1\frac{1}{2}$

Chemung sandstone. 2 miles north of Sabinsville, Tioga co. Pa.

4 Oral aspect of another adult, showing similar characters, some of them more pronounced. Here the anal pyramid shows its composition of 10 triangular plates. x $1\frac{1}{2}$

Chemung sandstones. Loose at Alfred N. Y.

5 Aboral aspect of a large individual

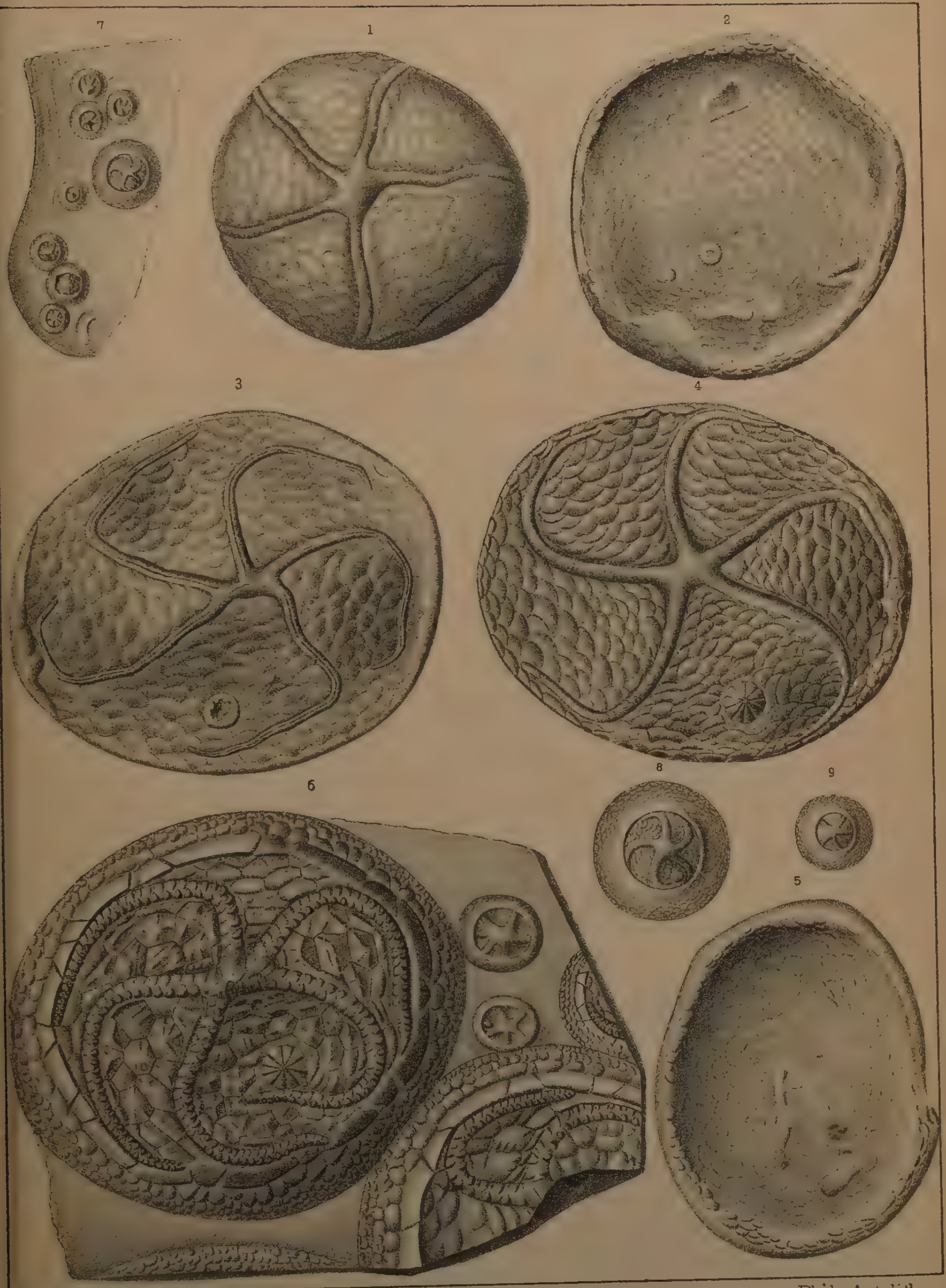
Chemung sandstones. Loose at Belvidere N. Y.

Agelacrinites hamiltonensis Vanuxem

p. 184

6 A drawing made from a gutta-percha replica of the original. This replica, on comparison with Vanuxem's figure in the report on the geology of the third district, is seen to lack parts of two individuals, but it shows the detailed structure

AGELACRINITES



G. B. Simpson del.

James B. Lyon, State Printer

Phil. Ast, lith.

of one adult with portions of five other individuals in various stages of growth. Noteworthy features of the adult are the form and direction of the rays, the large submarginal and small marginal plates and the sculptured surface of the interradial plates. The two very young individuals are specially interesting, as showing the relative width of the marginal area and the straight rays abutting against the broad border. x 2

This is not a reproduction of the figure given by Hall, in the 24th report of the New York state museum, but is a new drawing.

Hamilton beds. West Hamilton, Madison co. N. Y.

Agelacrinites buttsi ***sp. nov.***

p. 196

Fig.

7 A cluster of individuals attached to a shell of Ptychopteria. Natural size

8 The largest of the individuals x 2. Showing the very broad border composed of small imbricating plates, R 1–4 contrasolar, R 5 solar and the imbricating interradial plates

9 A younger individual, in which the border is relatively much broader and the rays direct. x 2

Supradevonic sandstone (Cattaraugus beds) Mt Moriah, Cattaraugus co. N. Y.

PLATE 11

(Original in the state museum)

Amnigenia catskillensis Vanuxem *sp.*

A slab of sandstone bearing 33 individuals of this species all with closed valves and buried in the mud at various angles across the lines of sedimentation. Reduced $\frac{1}{3}$

Oneonta sandstone. Oxford N. Y.

Amnigenia catskillensis

INDEX

Page numbers referring to descriptions of fossils are printed in black face type. The superior figures tell the exact place on the page in ninths; e. g. 168^3 means page 168, beginning in the third ninth of the page, i. e. about one third of the way down.

(Pages 239-240 were bulletin cover pages)

University of the State of New York

New York State Museum

Frederick J. H. Merrill Director

Bulletin 50 March 1902

HORN AND BONE IMPLEMENTS

OF THE

NEW YORK INDIANS

BY WILLIAM M. BEAUCHAMP S.T.D.

University of the State of New York

New York State Museum

Frederick J. H. Merrill Director

Bulletin 50 March 1902

HORN AND BONE IMPLEMENTS

OF THE

NEW YORK INDIANS

PREFACE

It was expected that corrections and additions relating to the matter of these bulletins would be made from time to time, as these publications were intended to impart knowledge and call forth more. Among other traces of aboriginal occupation I have thus recently learned of camp sites extending some miles east of Pulaski, on the higher lands along the Salmon river. These were to be expected there, and they have the usual early relics. In the vicinity of New York, M. Raymond Harrington has successfully explored a number of rock shelters in Westchester county, and at Port Washington on Long Island he opened about 100 pits containing human and canine remains. I have also observed and located 50 of the Perch river mounds, to be described later. They are the same type as those of the Bay of Quinté. A trip to the Susquehanna in the summer of 1901 allowed a brief examination of the great shell heaps of Unio complanatus there, and secured a plan of Spanish hill. Some new sites have been examined there and elsewhere at my own expense.

S. L. Frey properly corrects an error of names. There was a large recent site at Fort Plain; but the Canajoharie of Johnson's day was at Indian Castle, Herkimer co. Names of villages often followed them in removals. Mr Frey also agrees with Gen. Clark in placing *Andagoron* half way between Sprakers and Auriesville.

He greatly deplores the fact that so many small yet valuable collections are being bought up and taken from the state. I hope that contemplated field work may soon increase our knowledge of town and camp sites. My thanks are due to many who have invited me to share in their explorations.

There are some things to add to what has been said of articles of polished stone. Mention has been made in a preceding bulletin of a fine, perforated stone ball, having a surface groove parallel to the perforation. This is from Genesee county and belongs to the state museum. I have since seen another fine example, found in Chautauqua county. To these may now be added a similar, but rarer form, heretofore reported only in Ohio. It is a flattened ball of polished gneiss, the short diameter being 1⅝ inches, and the long 2⅛ inches. The perforation is through the short diameter, and parallel to this, the surface is flattened, nearly a third of the long diameter being removed. It was found about 50 years ago in Marshall, Oneida co.

The long, slender and often double-pointed celts may now be assigned to the 16th century and the Iroquois, examples having been found on the Christopher site in Pompey. The flattened and constricted stone pipes, most nearly represented among the articles of polished stone by fig. 112, are now conclusively proved to belong to the 17th century, as before asserted. One with a perforated base was recently found in a grave at Brewerton, associated with European articles.

Visits to various sites and collections have added much to a knowledge of New York earthenware. Jefferson county is rich in pottery of bold designs, and vessels with handles and projecting beaks occur there. Excavation shows many new patterns and features. On Chaumont bay I dug up a little of the curious pottery which is partly ornamented by making an incision within, producing a small circular boss on the outside by pressure. This is not common even there. Some of the vessels have a bright look, caused by mixing a quantity of yellow mica with the clay. This is occasional elsewhere. In that county I have observed small rude faces on some clay vessels, and a rude attempt at a nose in connection with the three conventional circles.

In the bulletin on earthenware fig. 124 is of a vessel having a point in the center of the base. Thus it was figured and expressly described in a New York paper. W. L. Calver doubted the correctness of the statement, but could not at the moment obtain full access to the vessels. He has now changed his opinion. In a letter to me, dated Ap. 26, 1901, he says that a friend, in digging at Port Washington, "got a whole pot which had a pointed base." This form will therefore now hold the place claimed for it. I may add that the pointed base of a broken vessel has also been found in Jefferson county.

In treating of wampum, I regret not mentioning Horatio Hale's *Four Huron wampum records*, published with notes by Prof. E. B. Tylor of Oxford Eng. in 1897. I have not seen it; but one belt, in his opinion, showed an alliance between four nations, represented by squares. An older broken belt had a central diamond, so frequently used. This is "between a bird and a quadruped and three crosses with a circle (diamond) uniting their branches." These are all recent symbols. I merely call attention to these belts now, as doubtful opinions have been founded on them. Some fine ceremonial wampum has recently come into my hands, one call for a religious council still having the tally-stick attached. Mr Wyman also obtained some fine Ottawa belts in the spring of 1901, and the following summer Mrs Converse secured a large Canadian belt for one of her friends. I secured descriptions of all.

Mention may also be made of two fine belts belonging to the Douw family of Poughkeepsie N. Y. One is 2 feet long, 3 inches wide and has nine rows of white beads, crossed by four double diagonal lines of dark beads. This was a condolence belt, given by the Indians to Volckert Pieter Douw, on the death of his daughter in 1775. That year Mr Douw was a commissioner to treat with the Six Nations, and they returned one belt which he presented. I think this the second belt. It is on twine, has 10 rows, is 2 feet long and 3½ inches wide, and has three central designs in dark wampum. I made a satisfactory reading of both, but this is conjectural.

W. M. Beauchamp

LIST OF AUTHORITIES

The following works are referred to in the bulletin by the abbreviations at the left.

Abbott	**Abbott,** *Dr* **C. C.** Primitive industry; or, Illustrations of the handiwork in stone, bone and clay, of the native races of the northern Atlantic seaboard of America. Salem Mass. 1881.
Amidon	**Amidon,** *Dr* **R. W.** Letters to W. M. Beauchamp.
Beauchamp	**Beauchamp,** *Rev.* **W. M.** Iroquois games. Jour. Am. folk-lore. Bost. 1896. 9:269–77. *Also* Rau's Prehistoric fishing.
Benedict	**Benedict,** *Dr* **A. L.** Letters to W. M. Beauchamp.
Bourke	**Bourke,** *Capt.* **J. G.** Medicine men of the Apache. Ethnology, Bureau of. 9th an. rep't. Wash. 1892.
Boyle	**Boyle, David.** Notes on primitive man in Ontario; being an appendix to the report of the minister of education for Ontario. Toronto 1895.
Calver	**Calver, W. L.** Letters to W. M. Beauchamp.
Charlevoix	**Charlevoix, P. F. X. de.** Journal of a voyage to North America; tr. from the French. Lond. 1761.
Copway	**Copway, George.** Traditional history and characteristic sketches of the Ojibway nation. Lond. 1850.
Dawkins	**Dawkins,** *Prof.* **W. B.** Cave hunting. Lond. 1874.
Dawson	**Dawson,** *Sir* **J. W.** Fossil men and their modern representatives. Lond. 1883.
De Kay	**De Kay, J. E.** Mammalia. Zoology of New York. Alb. 1842.
De Vries	**De Vries, David Peter.** Third voyage of David Peter De Vries to New Amsterdam. N. Y. hist. soc. Trans. 3:91. N. Y.
Douglass	**Douglass, A. E.** Table of the geographical distribution of American Indian relics in a collection exhibited in the American museum of natural history, New York. Am. mus. nat. hist. Bul. N. Y. 1896. 8:199–220.
Evans	**Evans, John.** Ancient stone implements, weapons and ornaments of Great Britain. Lond. 1872.
Frey	**Frey, S. L.** Newspaper articles and letters to W. M. Beauchamp.
Higgeson	**Higgeson,** *Rev.* New England's plantation. 1620. Mass. hist. soc. Collections v. 1. 1792.
James	**James, J. B.** Popular science news. Aug. 1896, Ap. 1897.
Jones	**Jones, C. C.** Antiquities of the southern Indians. N. Y. 1873.
Josselyn	**Josselyn, John.** Account of two voyages to New England. Bost. 1865.
Kalm	**Kalm, Peter.** Travels into North America (1749); tr. by J. R. Forster. Lond. 1772.

Keller — **Keller, *Dr* Ferdinand.** Lake dwellings of Switzerland and other parts of Europe; tr. and arranged by J. E. Lee. Lond. 1878.

Kellogg — **Kellogg, *Dr* D. S.** Letters to W. M. Beauchamp.

Loskiel — **Loskiel, G. H.** History of the missions of the united brethren among the Indians in North America; tr. from the German by C. I. La Trobe. Lond. 1794.

Mackenzie — **Mackenzie, Alexander.** Voyages from Montreal, etc., to the Frozen and Pacific oceans; in the years 1789 and 1793. Lond. 1801.

Morgan — **Morgan, L. H.** League of the *Ho-de-no-sau-nee*, or Iroquois. Rochester 1851.

Murdoch — **Murdoch, John.** Ethnological results of the Point Barrow expedition. Ethnology, Bureau of. 9th an. rep't. Wash. 1892.

Nilsson — **Nilsson, *Prof.* Sven.** Primitive inhabitants of Scandinavia; tr. by Sir John Lubbock. Lond. 1868.

Ogilby — **Ogilby, John.** America: being the latest and most accurate description of New England. Lond. 1671.

Perkins — **Perkins, *Prof.* G. H.** Letters to W. M. Beauchamp.

Rau — **Rau, *Dr* Charles.** Prehistoric fishing in Europe and North America. Wash. 1884.

Relations — **Relations** des Jésuites. Quebec 1858.

Richmond — **Richmond, A. G.** Letters to W. M. Beauchamp.

Sagard — **Sagard, T. G. Le.** Grand voyage du pays des Hurons. Paris 1865.
Translated in Rau's *Prehistoric fishing.*

Schliemann — **Schliemann, *Dr* Henry.** Ilios. N. Y. 1881.

Schoolcraft — **Schoolcraft, H. R.** Historical and statistical information respecting the history, conditions and prospects of the Indian tribes of the United States. Phil. 1851–57.

Smith — **Smith, *Capt.* John.** General historie of Virginia, New England and the Summer Isles. Lond. 1624.

Southall — **Southall, J. C.** Epoch of the mammoth and the apparition of man upon the earth. Phil. 1878.

Squier — **Squier, E. G.** Antiquities of the state of New York. Buffalo 1851.

Tooker — **Tooker, W. W.** Lecture before Brooklyn institute, Nov. 1892.
Also in Rau's *Prehistoric fishing.*

Twining — **Twining, J. S.** Letters to W. M. Beauchamp.

Wood — **Wood, William.** New England's prospect. Prince society. Bost. 1865.

Zeisberger — **Zeisberger, David.** Manuscript journal of 1753.

HORN AND BONE IMPLEMENTS

Introduction

It is not usual to place implements of horn and bone among those first used by man; and yet there is no reason why they might not then have been common. Nothing should be inferred from their absence; for, while the harder articles of stone seem almost imperishable, those of bone soon decay, except under favorable conditions. They appear in the bone caves of France with early implements; and in Kent's cavern, England, elegant bone articles are found below the stalagmite. The artistic engravings on some of the early bone implements of France have a wonderfully modern look to the well trained eye, in spite of their well attested origin. All these were preserved under favoring circumstances. Those left unprotected quickly disappeared. Bearing this in mind, we can see that a sharp bone was as suggestive of use as a sharp stone to the primitive man, and the same remark applies to implements made of wood. The fact has been strangely overlooked, that thorns are natural awls and needles, and that hard wood knots preceded the stone-headed war club, that pointed sticks were the first fish spears, and that arrows, made entirely of wood were and still are used by some Indians of this land. The early tomahawk was but a hard wood club. A wood or bone age may thus even have preceded that of stone, leaving few or no memorials. They certainly coexisted.

In Evans's *Ancient stone implements, weapons and ornaments of Great Britain* are figures of Eskimo arrow flakers, with handles of fossil ivory and points of reindeer bone. In such cases bone preceded the stone which it formed into shape. Perforated tablets of bone, resembling American gorgets, had been found in Europe. Bone pins and needles were frequent, but this requires qualification. The pins represented would be called awls in America, and have no heads. Some needles have central perforations and double points, as with us, but others have terminal perforations in slightly expanded heads. Bone was used in England for chisels, beads and buttons; horn for axes, hammers, pickaxes, hoes and handles. In this work a figure is given of a bone harpoon from Kent's cave, which has barbs on both sides, but with a point differing from those

of New York. The *Epoch of the mammoth*, by James C. Southall, shows a horn harpoon from Switzerland precisely like some from Onondaga county.

25 years ago it was a notable fact that most of the bone and horn implements in the Smithsonian institution were from the Pacific coast, and perhaps the majority are still. Few were known from New York and New England, where their historic use is well attested. Little had been done in systematic excavation, and most articles at hand were surface finds of stone. A change has taken place; and the last 10 years have added wonderfully to our knowledge of implements of bone and horn. Comparatively little has been done in the Algonquin fields of the eastern counties of New York, but many an Iroquois site has yielded large quantities of these. Usually they were too low in the ground to be reached by the plow, lying in the refuse heaps or the deep ash pits of early villages, but coming forth as bright and unimpaired as when lost centuries ago. What they were will appear as we proceed.

When Verazzano visited Long Island in 1524, as many suppose, he found the Indians using fish bones for arrowheads, but farther west they had those of stone. In 1620 arrows were used against the whites at Nantasket creek, Mass., tipped with brass, eagle claws and horn. In the first volume of the Massachusetts historical society's collections is an account of *New England's plantations*, written in 1629 by Rev. Mr Higgeson. He said: ' For their weapons they have bowes and arrowes, some of them, headed with bone, and some with brasse." Capt. John Smith said of the Virginia Indians: "Their hookes are either a bone, grated as they noch their arrows, in the forme of a crooked pinne or fish-hooke, or of the splinter of a bone tyed to the clift of a little sticke, and with the end of the line they tie on the bait." Loskiel mentions hoes made of the shoulder blade of the deer, and other quotations might be given.

In a letter to the writer in 1880, Prof. George H. Perkins of Burlington university, Vt., said: "We have no implements of bone in Vermont, but from the other side of the lake are some split bones that may have been used as awls, and one very fine barbed spear point." This was a harpoon, barbed on both sides. At a

later day Prof. Perkins found a fine but modern bone mask in Vermont. Large village sites are rare in that state, but excavations might reveal something. Bone awls appear in some Illinois mounds, but do not differ from eastern forms. Bone articles found at Hochelaga (Montreal) are precisely like those of New York and those of the old Huron country, near Georgian bay, are similar. Rarer forms have been obtained from the curious mounds about the Bay of Quinté. A one-sided harpoon from Manitoba is of a common New York type. Bone articles are rarer in Pennsylvania, perhaps through lack of excavation, nor are they common near the seacoast, where many things supply their place.

As most of the early visitors to New York were migrants, stopping but a few days or weeks in a place, the absence of bone implements on their camp sites is no proof that they had none. Destruction came in many ways. James E. De Kay, in his *Zoology of New York*, says, in speaking of the common deer:

It has often been a matter of surprise that, while so many horns are annually cast, so few are ever found. This is to be explained by the fact that, as soon as they are shed, they are eaten up by the smaller gnawing animals. I have repeatedly found them half gnawed up by the various kinds of field mice, so numerous in our forests.

It may be added that a friend recently found that mice had gained access to his bone articles and badly gnawed some which were centuries old. Besides this, mere camps did not produce sufficient ashes or carbonaceous matter to preserve perishable articles, while those of stone remained. They are not frequent in graves, but must be sought where fires have been long in use. The dumping places, bordering most Iroquois villages, yield many and some which are fine. Nothing preserves them so well as ashes, and these accumulated to a great depth where a fire burned for many years. In some circular lodges the floor was occasionally cleansed by drawing all accumulations to the edge of the lodge, and filling the center with fresh earth or gravel. This produced hut rings, and relics are to be expected near the border, not in the center. Where a village was edged with deep ravines, refuse was thrown down the banks, but sometimes a deep hole was found or formed and gradually filled. These have rich deposits.

The Iroquois had no regard for bones as sacred, but Canadian Indians venerated many, or at least were careful of them. Some would not eat the marrow of the backbone, this being bad for the back. The Jesuits said the Hurons considered "fish intelligent, and also the deer and elks." It is added: "This is why they do not throw the bones of the latter to the dogs, when they are hunting, or the fish bones of the former when they are fishing. Otherwise, upon the warning that the others would have of it, they would hide and not allow themselves to be taken." Some Algonquins gave their dogs no bones of beavers, female porcupines, or birds taken in snares, for the same reason, but burned them. It was best to throw the bones of a snared beaver into the river. All were collected with care. Bears bones were burned or buried under the hearth. Some Algonquins burned dry beaver bones to learn the source of pestilence.

The Iroquois were not fond of working in stone, though they did this well, but long maintained their liking for bone and horn. Occasionally they neatly carve such material yet. Some of their early articles have preserved that wonderful polish, which sometimes creates doubts in those who have not dug up such articles, as the writer himself has done. They are usually plain, but early decoration sometimes occurs. The smoothness of the work is often surprising, and the luster may have come from the absorption of fat. The relative abundance of bone articles on early Iroquois sites is another subject worthy of remark, but this appears only through excavation. On many of those over 300 years old more tools or ornaments of bone than of stone will be found; nor is this proportion confined to those of established age and origin. The writer and four others did a successful day's digging at an early fishing village in Jefferson county, and he found the only flint arrowhead which was secured. Nearly all the other relics were fragments of pottery and pipes, and various forms of polished bone. Another prolific village site in Onondaga county has a similar character, chipped stone implements being exceptional, and those of bone the rule. Yet fine triangular arrowheads and small basalt celts have recently been found there, but bone is more frequent.

While occasional examples in Europe might pass for those of

America, by far the larger part are distinct in appearance. References will be made to some for comparison. In North America a division of districts might be made, but there is much uniformity of type in common articles. A bone awl from a cliff dweller's home may be in no way distinguishable from one made in New York. Village sites are the best places for determining the age and relations of bone articles. At fishing places, frequented by many visitors of different periods and families, the numerous and fine remains of this kind rarely permit any orderly séquence to be assigned them.

It will be noticed that a large proportion of the bone articles here figured are from the central part of New York, the home of the Iroquois One reason for this is that the writer's own work has been mainly there, but a more important one is that this region is nowhere equaled in articles of this kind. Visits were made to some other places, and correspondence was had with good antiquarians, to see what additional matter could be secured. Moderate results were obtained, and some of interest, but all pointed to the fact that the early and late Iroquois, with their kindred, were the workers in bone *par excellence*. As these had some early hold on Lake Champlain, though no forts or towns, it was to be expected that something would be found there. The small and briefly occupied sites did not, however, produce sufficient preservative material for large results. A letter from Dr D. S. Kellogg of Plattsburg states the case there:

I don't know that I can add much to my *bony matter*. The most I have found was in fire heaps; among charcoal, ashes, fire stones, flint implements, celts and fragments of pottery. There are many awls or needles, and some very fine fragments of notched harpoons. The bones and teeth of different animals are quite numerous, and mostly broken. Deer horns are often found, and some of the tines look as if they had been used as punches.

A long resident population, large villages, and perhaps unusual skill, made the Iroquois home territory a treasure house of the articles now to be considered. They are abundant, fine, and in general remarkably well preserved.

Besides those authors more explicitly quoted in the following pages, reference may be made to some writers in the way of general distribution. Dr Henry Schliemann's *Ilios* has bone needles with

perforated heads, and small awls differing from those of New York, but some bone knives and large awls resemble ours. The Irish implements are quite different. In the *Lake dwellings of Switzerland*, Dr Keller figures a large awl much like some in New York. The needles shown are perforated at the end, but fig. 35 of plate 103 is suggestive of America, as well as a harpoon on that plate. Plates 5 and 20 also have harpoons resembling those of New York. In the *Antiquities of the southern Indians*, Mr Jones figures some of the frequent bone gouges, but they differ from the few found here. Prof. T. H. Lewis of St Paul Minn. has found the blunt bone implements here called punches; and his descriptions of awls and harpoons are like those farther east. A bone fishhook has been found in Illinois. In general the whole territory from the upper Mississippi eastward to New York and the ocean may be considered one district with local variations.

Awls and knives

It is quite probable that many small bone articles commonly called awls were really used as arrow points, and some have regarded the large and sometimes massive forms as daggers. In the paucity of stone arrowheads and knives on many Iroquois sites of the 16th century, such uses seem reasonable, and have much to support them in the notes of early discoverers. No special classification of these pointed tools will be attempted here, but the reader will see that some would have been very effective as warlike weapons. This would appear more clearly if all could be represented here in actual size. A few are reduced for illustration, and many of the large forms are omitted because just as well shown by smaller examples. Frequent small awls are also found which are but sharpened splinters of bone, as well described by words as figures. The outline of the tool often means nothing. The point of the awl is the only essential thing. In considering the better finished articles of all kinds, it is to be remembered that these are but a selection of typical forms out of thousands which have individuality, constantly varying in one way or another.

Then there are forms which have a rounded point, not adapted for piercing or any other known purpose. These are usually of

horn, and are commonly classed with awls, though often termed punches. It may be best to assign them this name here, though this places them with cylindric articles usually having rounded ends. While they differ much in form from these, they seem to belong nowhere else; and even then we do not know their use.

While a warlike character has been contended for in the case of some of the larger and longer forms, some persons have seen in the more slender examples pins, either for the hair or apparel. The latter supposition is questionable in most cases; and those of great length and sharpness would have been neither comfortably nor safely worn in the hair. Some may be assigned to this use. Many combine a broad, knifelike form with the sharp point of an awl, if such they are. They seem not sharp enough for cutting, but would have been useful in skinning any animal. Among the Iroquois stone axes or celts were not abundant, and were probably prized. For deer-skinning the bone knife did just as well. It was lighter, more easily made, was sometimes distinct, but often combined the awl point with it, as our pocket knives practically do.

While the so called awls were often made of small splinters of bone, the larger ones often left some natural feature almost untouched. The jawbone of some animal would be sharpened, the teeth perhaps being still in place, but this is rare. Long awls quite commonly leave one joint almost unaltered. This is a frequent feature of smaller forms. The bills of water birds were often utilized, and fish spines required but moderate change, some none at all. Most of these will be illustrated here, but the diversity of form is endless.

We need not raise the question whether the sharpened splinter, requiring a handle, or the larger implement requiring none, had priority in time. Here they coexist, but it may be advantageous to treat them separately, as far as it can be done. Yet many large awls are formed from splinters, and small ones occur with one joint, almost or quite unaltered. Another evident distinction will be found between flat and cylindric awls, and between these and the frequent and fine three-sided forms. These distinctions are convenient in description, but have no other value. The maker simply fashioned the awl according to the original form of the bone. There

are a few exceptions to this. Little need be said in regard to the mode of forming awls, so simple was the process. Examples will be given of the progressive stages of less common implements. The smaller awls may be described first.

Fig. 1 is a very sharp implement, and much thicker than most of this size. The broad end is neatly finished, and near that end there is a distinct groove on the convex side. This may have secured it more firmly to a handle. It is not as much rounded as most of its class, but has well defined angles. It comes from the fort west of Cazenovia, and is about 300 years old. On that site many bone implements have been found. Fig. 2 is from the same place, and was found by the writer. It is both sharp and slender, and the notch on one side may also have been for attachment. The longitudinal groove is natural, and the base is unfinished, as in most examples of this kind.

Fig. 6 is a curved awl, quite slender and nearly cylindric. The base is rounded and has four grooves. From its finish and ornamental character, it may have been a hairpin. It is from a prehistoric site in Pompey.

Fig. 10 was in Dr. Hinsdale's collection, and was found by him on the site last mentioned. This was a considerable town on a hill in Pompey, where many beautiful articles of bone and horn have been discovered in the ashes. It is a short and not very thick bone, flat on one side and a little rounded on the other. Both ends come to a sharp point. It may be said here that all the figures are of actual size unless otherwise noted, and that all articles are of bone when not described as horn. The latter are comparatively few in proportion. Fig. 11 is from the same place, and is a fine flat bone, sharp and highly polished. The base is neatly indented. Fig. 22 was found near it, and is a good representative of a large class where some original outline of the bone remains. Jaws of animals are often worked merely to a sharp point, and the beaks of birds are naturally ready for use.

Fig. 23 is from the fort west of Cazenovia, usually placed at the end of the 16th century. It is a narrow cylindric and tubular bone, smoothly cut at one end and beveled at the other. It is a frequent form, and some have thought it a primitive arrow point.

Fig. 24 is from the prehistoric town in Pompey, already mentioned, and known to local collectors as the Christopher site. By this name it will be designated in further descriptions. It may be a flat awl, but the form and side notches would be appropriate for an arrowhead. The base is neatly rounded, and it may have been an ornament. This would explain its high polish, which would hardly be expected were it simply the point of an arrow.

Fig. 25 is a handsome awl from the fort west of Cazenovia, locally known and hereafter designated as the Atwell site. It is thin and sharp. The under side is concave, retaining this natural feature. The upper is flat and a little angular. Fig. 27 is a very small cylindric awl, with a rounded base, found by Dr Hinsdale at Brewerton. Many of Dr Hinsdale's articles are now in the state museum. Several examples of this kind are known, but it is not a frequent form. They are usually larger.

Fig. 45 might be classed with awls, but the angular and grooved projection at the base suggests its use as a pick. The pointed portion is cylindric. This is from the Christopher site.

Fig. 49 is another of the double-pointed, flat awls. It is quite thick and a very fine specimen of this form. It was found by Dr A. A. Getman in the vicinity of Chaumont bay, Jefferson co., where bone and horn relics abound. Fig. 67 presents a similar outline, but is slightly gougelike at one end. It is of moderate thickness and quite white. It was found by Luke Fitch of Pompey, on the Christopher site, and is now in the Bigelow collection at Baldwinsville, with many others from that spot. Bone articles there have been finely preserved in ashes.

Fig. 69 is from Dr Getman's collection. His many fine articles are from several sites in the vicinity of Chaumont bay, but several miles apart. This fine and sharp awl is nearly flat on one side, but rounded on the other. One edge is also broadly angular, and the other curved.

Fig. 71 was found by Dr William G. Hinsdale of Syracuse, on the Sheldon fort site, lot 69, Pompey. This may have been occupied about 1630, and has many European articles. It is a sharp implement of deer horn, cylindric toward the point and somewhat flattened near the base. This is neatly rounded, and there is an

indentation on each side above. For a considerable time Dr Hinsdale made a specialty of bone and horn implements, and was very successful in collecting them on early sites.

Fig. 76 is a very slender and curved awl, with a sharp point and a neatly rounded base. It is polished all over, and much more curved than usual. This was found by Oren Pomeroy near Chaumont bay. He has many fine articles of bone and horn. Fig. 74 is a very slender bone awl from Pompey. The form is not rare.

Fig. 80 is in the collection of the Buffalo academy of science, and was found in or near that city. It is worked all over, and at first suggests an unfinished hook. The two sharp points would be unnecessary in that case, but it might have been attached to a wooden shank and used in this way. On the other hand, the longitudinal grooves favor the idea that the ultimate intention was to cut it in two, thus making two small awls. The article is unique in its present form.

Fig. 81 is a fine and flat awl found by the writer at the mouth of Perch river, Jefferson co., in 1899. It is moderately curved. The site is an early one, and yields much in pottery, bone and horn, and but little in stone. Fig. 82 is from the same county but not the same place. The double points suggest an awl, but are not very sharp. It may have been a pin. The indented center also suggests another use, that of a fishing implement made by some primitive peoples, but more cylindric than this. In that the line was attached to the center, the bone brought parallel to the line and covered with the bait. When this was swallowed, a jerk brought the implement across the throat, and secured the fish. The Eskimos use these for catching waterfowl. Dr Getman has the center of a similar article more angularly indented.

Fig. 104 is a flat, triangular and perforated piece of bone, of small size and sharp at both ends. It may have been used in several ways, as an awl, an arrowhead, or the point of a fishhook. It is from the Atwell fort, and is in the collection of J. H. T. E. Burr of Cazenovia, who has many interesting articles from this site.

Fig. 121 might be called a needle but for its size. The form is generally triangular, but the point and base are rounded, the latter having three notches. It is quite flat and has an elliptic perforation

near the base. It is from Jefferson county. Fig. 125 is similar and from the same county, but differs in having a sharp point, a higher and circular perforation, and no basal notches. Fig. 127 is another perforated awl or needle, sharp at both ends, and having a central perforation. It is generally flat, but somewhat undulating in form, and may have been used in fishing, though rather large for this. It came from the fort south of Pompey Center, occupied about 1640. Fig. 122 is much like this, but shorter and broader. This fine article is nearly flat, and a little rounded on the upper side. The reverse is slightly concave, and both sides are polished. This is from the earlier and prehistoric Christopher site, and is now in O. M. Bigelow's collection at Baldwinsville. Fig. 261 is in the same collection, and is a very fine bone awl from the Seneca river north of Weedsport. It is somewhat angular, and the points at each end are rounded. The color is dark brown, and it was probably colored and preserved by iron in the soil. Fig. 271 is a half round and slender bone awl from the Atwell fort. It is worked all over and pointed at both ends. It is a fine and not very rare form, having one slender and one obtuse point. Fig. 275 is from the same place, and is a little wider, and with a more obtuse basal point.

Fig. 302 is a unique form, curved, and having four notches on each side near the rounded base. It may have been used as a hair-pin or for ornament, and is quite slender. This was found by Dr R. W. Amidon of New York city, at Point Peninsula in Jefferson county. While summering on Chaumont bay, he has done much valuable work and collected many fine articles. Fig. 315 is from the same collection, and was found in the vicinity of Chaumont bay. It is a small and flat implement, one end being pointed, and the other rounded and nearly like a chisel. Fig. 317 is also from the same collection, but is a frequent form on many sites, usually but slightly worked. It appears among European articles and is a bird bone.

These figures sufficiently represent the smaller forms of what are commonly called awls, but a few others may be mentioned. In later days the iron point replaced that of bone, and Aunt Dinah, the aged Onondaga squaw, had an iron awl with a cylindric handle of curved bone, $3\frac{1}{2}$ inches long. This had transverse grooves, and much resembled some early bone beads. A fine and slender bone

awl comes from a site near Munnsville. Most of the relics there are of the historic period. In the Richmond collection is a nice awl from a burial mound (?) at Mannsville, Jefferson co., which is 3 inches long, and in the same collection is a curious flattened one of the same length. This is curved, having a single convex curve on one side, and two concave curves on the other. This comes from Madison county. Many fine and sharp awls have been found by Dr Hinsdale on what is called the *Kaneenda* site, north of Syracuse. Many also occur on the mixed sites at Brewerton. Dr Hinsdale also collected slender and flat awls on the Sheldon site, lot 69, Pompey. Among those from Brewerton is a fine double-pointed horn awl, 4½ inches long, and another of the same material, very slender and a little curved, not unlike a dentalium shell in outline. This is 1½ inches long. Another of bone is 2 inches long, curved, polished and very slender.

Fig. 44 is a sharpened fish spine from Brewerton. These are frequent and of many sizes. Fig. 70 was made from the bill of a sheldrake, and is from the Atwell site and in the L. W. Ledyard collection. These also are frequent, with the bills of other birds.

Among the larger awls, as we may call them for the sake of a name, many of the same forms appear, often grading into those which might be differently classed. Some which have a distinctly narrowed and sharpened point, have also broad blades suggestive of knives. Another use is even more probable. In the *League of the Iroquois*, p. 363, L. H. Morgan illustrates the "*gä-ne-u'-ga-o-dus-ha*, or deer horn war club." After describing the common club of hard wood, he says of the one just named:

This species of war club was also much used. It was made of hard wood, elaborately carved, painted and ornamented with feathers at the ends. In the lower edge, a sharp-pointed deer's horn, about 4 inches in length, was inserted. It was thus rendered a dangerous weapon in close combat, and would inflict a deeper wound than the former. They wore it in the girdle. At a later period they used the same species of club, substituting a steel or iron blade resembling a spearhead, in the place of the horn. War clubs of this description are still (1851) to be found among the Iroquois, preserved as relics of past exploits. It is not probable, however, that these two varieties were peculiar to them; they were doubtless common over the continent. The tomahawk succeeded the war club, as the rifle did the bow.

The careful reader will find that the name of tomahawk was originally applied to a wooden weapon, and the arming of this with a cutting point was a step in the evolution of a formidable implement of war. Adopting Mr Morgan's statement, we can refer to this weapon some of the broader forms called awls, and particularly those horn points which are rounded rather than sharpened. To the latter we can assign no more probable use. The horn in his figure of a club has the curve of the antler prong. In the following descriptions a few of the broader forms will be classed as knives, though their use, strictly as such, may be considered doubtful.

Fig. 3 is a flat and sharp awl, generally wide, and expanding still more at the base. Within half an inch of this broad end are two transverse grooves, quite close together. It is finely polished, and came from the Nichols pond site in Madison county, the scene of Champlain's attack in 1615. It is now in the collection of A. H. Waterbury at Brewerton. Fig. 4 also belongs to him, and was found on the east side of the mouth of Chittenango creek, lying in the water. It is moderately broad, fine and sharp. For the most part the edges are parallel, but expand near the broad end into a well curved base.

Fig. 7 is a fine flat and narrow awl, perforated near the base. This came from the recent site in Rice's woods, east of Stone Arabia in Montgomery county. It is somewhat angular. Fig. 8 is a beautiful, very slender and symmetric awl, found east of the Canajoharie cemetery. It tapers from near the base, on either side, to the sharp point at one end, and abruptly curves to the obtuse point at the other. It is the largest of this form the writer has seen and is nearly or quite cylindric. Fig. 9 is in the Richmond collection, and came from Nichols pond. It is a slender and flat awl, with one side nearly straight, and the other curving outward so as to form a broad base.

Fig. 15 is fine and flat, tapering regularly from near the base to the point. The base is angular, the joint not having been fully worked down. Found on the Atwell site by Luke Fitch of Watervale. Most of his articles are now in the Bigelow collection, making further personal reference unnecessary. The next two articles were found by the same person at the same place. Fig. 16 is

another slender and long bone awl, tapering directly from a rather broad base to the sharp point. It is half round in section, and is polished all over. Fig. 17 is also half round, tapering from a wide center to each end. The base forms an obtuse point, and there is a deep notch on one edge just above it. A slight ridge extends from near the center to the sharp point.

Fig. 18 is a highly polished bone awl, found by Oren Pomeroy in the vicinity of Chaumont bay. The edges are parallel till near the point, and it has the common flat form. In one edge, just above the rounded base, is a notch, and above this several short and slight cuts. Fig. 19 is one of the prettiest of Mr Pomeroy's articles. It is broad near the center, regularly tapering to a sharp point at one end, and to a narrow rounded base at the other. It is nearly flat, but with rounded edges. Its polished surface has been beautifully mottled by fire, making it very attractive in appearance. A recent inspection showed that in two years its rich hues had greatly faded from exposure.

Fig. 20 is a long and nearly flat bone awl or pin; probably the latter, as the point is obtuse, and the base has transverse grooves as if for ornament. This is from the Christopher site in Pompey. Fig. 21 is from the same place, and is a fine flat implement, tapering from the broad base to the point.

Fig. 28 is a curious curved implement which may be called a large awl. It has been cut lengthwise more than half way along the edge, thus exposing the cavity of the bone. The point is but moderately sharp. It came from the Atwell site, and was in the Ledyard collection.

Fig. 29 is in Dr Getman's collection at Chaumont. It is a much curved, cylindric and pointed bone. The base is irregular and but very slightly worked. This was probably used in a war club. Fig. 30 is one of those forms mentioned, the point suggesting an awl, and the broader part a knife, or, perhaps still better, an instrument for skinning deer, as the parallel edges are rounded and not sharp. The rounded base is nicely worked, and the point is formed by a concave sweep on both edges. Dr Amidon found this near the village of St Lawrence, in Jefferson county. Fig. 37 may be compared with this, differing but little in outline. It is highly polished,

and is flat, with rounded edges which are not parallel. The base is broad and notched. It is from the Christopher site in Pompey, and is not a frequent form.

Fig. 31 is a beautiful article found by Dr Getman near Chaumont bay. The edges run in a straight line from near the rounded base to the sharp point. The base is deeply notched, and thence a narrow groove extends on one surface to the point. The implement is flat, and quite brown in color.

Fig. 32 is from the island at Brewerton, where so many fine bone articles have been found. It is a beautiful implement, worked all over, and while generally flat, it has beveled edges. There is a sharp point at each end, and it is less angular there. This is in the Waterbury collection, as is the next. Fig. 33 resembles the last, but is broader, shorter, and has but one point, while tapering toward the base.

Fig. 34 is a peculiar long and slender awl from what is called the Cayadutta fort site, in Fulton county. It has but one point, but the long shaft toward the base is unusually slender. Many fine bone articles have been found on this early site. This one is in the late A. G. Richmond's collection. The fort was probably occupied about 1600, or a little earlier.

Fig. 38 is a unique article from Brewerton, and is in the Waterbury collection. It seems part of a bear's lower jaw, cut down and sharpened for an awl, but with most of the teeth remaining. This is a rare feature.

Fig. 39 is a fine and sharp bone awl, nearly flat, which was found by G. W. Chapin of Fonda, at a site on Wemple creek, 3 miles north of the Mohawk river. It is a large, well finished and symmetric awl, 7 inches long, and therefore not of the very largest size. Mr Chapin found it in ashes, 18 inches below the surface. It has some grooves near the well wrought base. Thanks are due for the loan of this fine implement.

Fig. 40 is a remarkably fine example of a flat bone awl, approaching the knife form. It is widest in the middle, tapering regularly toward each end. Near the narrow and rounded base is a notch on each side. This is from Rice's woods, near Stone Arabia.

Fig. 41 is a fine example of a frequent form of bone awl, or pos-

sibly a dagger. The base does not suggest its use in a club, it is so thick. At that end the joint is neatly worked down, but not obliterated. Thence it tapers regularly on all sides to the sharp point. It is highly polished and is a large specimen of this class, being about 5½ inches long. It was found by Dr Hinsdale on the Christopher site. Most articles from this site were collected by Luke Fitch. Fig. 50 is another of these massive awls, if they may be called so, found by Dr Hinsdale at the Sheldon fort in Pompey. It is much like the last, but is both broader and shorter, and the base is less worked. Fig. 51 is another fine article of this class, from the Atwell fort. It is large, highly polished, and is worked almost all over. This is in the Burr collection. Fig. 295 is a much more slender example from the Christopher site, and now in the Bigelow collection. The base is left unworked. Fig. 325 is another massive example from Pompey in the same collection. It is 8¾ inches long, but is much reduced on this plate. It is well worked and somewhat curved. Near the point the cavity of the bone is exposed.

Fig. 46 is a double-pointed flat awl, ornamented with crosshatching, a somewhat unusual feature. This was from Jefferson county, and in the Twining collection, as was the next. Fig. 47 has an ornamentation of grooves, and three perforations toward the base, which is indented. The lower perforation is elliptic, and the others circular. The edges are slightly curved, one being concave.

Fig. 48 is a fine flat bone awl from Pompey, in the Bigelow collection. It is thick and highly polished, with a moderate ridge on one side. Fig. 54 is from the same place and in the same collection. It is thick and highly polished, with a very sharp point. There is a diagonal groove across the base, which may be natural.

Fig. 55 is a curved bone awl from Brewerton, somewhat flattened but having the edges rounded. It is partly hollow. This is in the Waterbury collection. Fig. 57 is a thin, flat, slender, and very sharp bone awl from Pompey, in the Bigelow collection. Fig. 59 is in the same cabinet, and is from the Christopher site. It is a much curved bone awl, broad in the center and pointed at both ends. The convex side is broadly grooved. The implement is triangular toward the broad end and flattened toward the narrow point. Fig. 68 is from the same place. It is a fine, sharp and slender awl,

ornamented with grooves near the base, and this feature suggests a pin. Fig. 116 is a fine flat bone awl, highly polished all over, and tapering from the broad base to the point. The reverse is slightly concave. From the same site as the last. Fig. 128 is from the same place, and is placed with the awls for convenience. It is a hollow and nearly cylindric bone, well worked, and beveled for more than half its length across the cavity of the bone, a rounded point being produced.

Fig. 312 is a fine and sharp bone awl, found by Dr Amidon in the vicinity of Chaumont bay. Some lines may be for ornament. One side is flat and the other angular. Fig. 334 is one of the finest bone awls seen by the writer. It is from the same region as the last, and was found by Oren Pomeroy. In the plate it is reduced, but is 8 inches long, quite straight on one side and but slightly emarginate on the other. It is cut down so that the natural cavity appears for two thirds of the length. The edges of this are highly polished, as is all the convex surface. It is very sharp, and for its size very slender.

Fig. 335 is a slender and flattened awl, 8⅝ inches in extent. Both edges are curved, the one being convex and the other concave. The base is broad and convex, with a broad and curving notch toward the inside of the implement, which is much reduced in the plate. It was found on the border of Canajoharie village, in a grave which contained a very fine and perfect R. Tippet pipe of white clay, and is in the Richmond collection. Fig. 339 is a fine, long and slightly curved bone awl, found by Dr Hinsdale at the mouth of Chittenango creek. There is a small perforation near the tip. The width is quite uniform, but with a broader base, and the general surface is flat. In the plate it is reduced, being 8⅛ inches long.

In A. G. Richmond's collection is a fine and slender bone awl from the Otstungo site, near Fort Plain. It is 7¼ inches long. A fine flattened and angular awl from Nichols pond is 4⅝ inches long. Besides others, Dr Hinsdale found a long and nearly straight bone awl on the Sheldon site. It is 8 inches in length, and is angular. Another bone awl from the same site, having a double curve, is 5½ inches long.

In the Richmond collection are the following three awls. A fine

and regularly tapering one is from England's woods in Montgomery county, where there is a recent site. This awl is $5\frac{5}{8}$ inches long. Another of a straight and slender form is $7\frac{1}{2}$ inches long, and came from the Cayadutta fort. A joint forms the base of this. A similar straight and tapering awl is from the same fort, and is $7\frac{5}{8}$ inches long. This is worked throughout.

Mr Van Epps has many fine articles from the above site. Among these is a fine bone awl, $4\frac{3}{4}$ inches long, generally rather wide, but compressed toward the base. It is ridged on one side. Three long ones taper from a moderately broad base to a sharp point. One is 6 inches long, another is $7\frac{3}{4}$, and another 8 inches in length. Many other fine ones have been found on this early site.

Double-pointed awls occur in the mounds of Manitoba, and the leading forms and features are found throughout the world. In Canada there is a close correspondence with New York forms.

On Long Island Mr Tooker found the bones of the deer abundant in many shell heaps, but implements of this material were not frequent. Near the city of New York a few awls have been found. John B. James described one fine specimen from Van Cortlandt park, which was $5\frac{1}{2}$ inches long and tapering in the usual way. In the shell heaps bones have been often found which had been split open to extract the marrow. Such examples occur elsewhere.

From the Atwell fort comes a large, straight and thick awl, polished all over, which is $8\frac{1}{4}$ inches in length. Another fine and straight awl is from Brewerton. It is $5\frac{1}{4}$ inches long, and has an expanded base. A very slender awl from the Christopher site is $4\frac{7}{8}$ inches long, and has a point at each end. It becomes narrow toward one end, and then expands again. This article is quite unusual in form. Among other long awls may be mentioned one in the Buffalo academy of science which is 7 inches long.

At the mouth of Perch river, in Jefferson county, the writer dug up a fine polished bone awl, which was $7\frac{7}{8}$ inches long, and nearly flat. It was not straight, but distinctly bent about a quarter of the way from the base. Another slender Jefferson county awl is $6\frac{1}{2}$ inches long, and was found by Dr Amidon. Most of his best bone relics have been from two sites. This awl is angular, light colored, and thoroughly worked except at the base.

These examples will suffice to show how fine, abundant and widespread these implements are in the Iroquois territory, but it might be unwise to suppose they were less used elsewhere.

Fig. 5 is one of the broad and flat forms, which have a narrow and sharp point like an awl, but are otherwise suggestive of knives. They are not usually sharp enough for cutting flesh or hides, and a party of excavators jocosely called them paper knives. They might now answer for these. They may have been inserted in war clubs, but it is more probable they were used in flaying beasts. This fine example has a very angular outline, the broad surface suddenly contracting toward the slender and sharp point. It was found by Dr Hinsdale on the island at Brewerton. Fig. 26 is a flat and thin bone knife from the Atwell fort. The form is broad, the outline curved, and the base neatly rounded. There can be little doubt of its use. Two other fine examples have been described among the awls. Fig. 42 is one of the most pronounced forms. It is from the Christopher site, and is in the Bigelow collection. The general form is broad, the edges not quite parallel, and it is everywhere polished. On the reverse side it is broadly concave. One end abruptly narrows to a point, and the base slopes to a point on one edge. One surface is rounded, but it becomes thin and flat toward the point of the implement. This is one of the finest examples of this form yet found, and its use as a skinning implement can hardly be questioned.

Fig. 43 is another fine specimen, found by Dr Hinsdale on the island at Brewerton. It is flat and has nearly parallel edges. One of these is curved to make a sharp point, and there is a slight indentation near the rounded base. Fig. 58 is another, still finer and also more definite in character. It is in the Bigelow collection, and from the Christopher site. It has a double curve at the base, which is rounded. The edges are thick and mostly parallel, and it is worked on both sides. It is pointed, and the upper surface is moderately ridged. The outline is that of a broad knife, but there is no long cutting edge, and it may have been used in a war club, but more probably as a skinning implement. Fig. 60 is a fine article of the same kind, flat and with a longitudinal groove on one side, and somewhat rounded on the other. It has a broad point, and the base

may have been broken. This is from Brewerton. Fig. 61 is a fine, flat bone awl or narrow knife from the Cayadutta site. The point has been lost, and one edge ran straight to this. Most of the length the edges are parallel. The base shows a transverse cut close to the ornamental grooves, and it seems to have been broken there. The carving is of straight lines variously arranged. This is in the collection of Percy M. Van Epps of Glenville.

Fig. 62 is a flat and curved bone implement, one of the broad, rounded ends being sharpened. The edges are neatly rounded, and it is nearly a quarter of an inch thick. It was found by Dr Hinsdale on the island at Brewerton. Fig. 65 is fine and thick, and is polished all over. It is somewhat angular, and the reverse is concave. This is from Pompey and in the Bigelow cabinet. Fig. 66 is a broad, flat and curved bone knife, worked all over and ornamented with straight lines variously arranged. This was found near the village of St Lawrence, and belongs to Charles Crouse of Chaumont. These ornamented articles seem more frequent in Jefferson county than elsewhere.

Fig. 75 is unique. It is a thin and neatly worked knife, made from the antler of a young deer. It was found by George Slocum in the Onondaga valley some miles south of Syracuse.

Fig. 84 is a broken bone implement from the vicinity of the village of St Lawrence, and is decorated in the frequent style of that region. It suggests a long knife with parallel edges. These are rounded. The reverse is flat with a longitudinal groove. Fig. 88 was found by Dr Amidon near the same place. It is flattened and fine, with a longitudinal groove in one surface. These are usually part of the natural cavity.

Fig. 113 is a form frequent in Jefferson county. One collection has many and fine examples, but figures of these could not be procured. One similar to this, but larger, has four perforations, and some others have the same number. The one here represented is in the Bigelow collection and from the Christopher site, showing the probable migration of the early Onondagas from Jefferson county. It is highly polished all over, is nearly flat, and is pointed at both ends. The edges are rounded, and it has two perforations. Fig. 115 is from another early Onondaga fort, the Atwell site. It is flat, dark, and polished all over. One end is pointed and the

other rounded. The edges are rounded, and there is one perforation. Fig. 282 may be merely an awl, but is very broad. It is polished all over and is quite thick. The base is indented, and the edges are slightly convex. The frequent groove appears in one surface. This is from the Atwell fort.

Fig. 305 is the first in a series of three illustrating the formation of a bone knife, kindly furnished by Dr R. W. Amidon, and all from Jefferson county. This is a long medullary bone, split and chipped to a flat surface, the outside surface being left untouched. Fig. 306 is of a flatter bone, not only chipped on one side but brought to a knife form. Fig. 307 is worked into better shape, and is ready for the final grinding and polishing. This is whiter than the other two.

Fig. 114 is from Jefferson county, and made from a split bone. One end is pointed, and the base is nearly square. There is one large perforation near the edge, both edges being much curved.

A rude bone knife was found on the Seneca river, nearly opposite Three River Point. The general form is that of a case knife, resembling the bone knives the Onondagas made for sale nearly a century ago. The article is 3⅝ inches long, but the blade is short. A flat bone implement of the knife form comes from the Christopher site. It is worked all over, has a large central perforation, and rounded edges, indented on one side toward the broad point. The length is 4 inches and the breadth ¾ of an inch.

Fig. 319 is a fine, broad knife made from the joint of a large, flat bone. It was found on the Onondaga outlet by Dr Hinsdale. It is highly polished on both sides; and for its length it is thin.

Punches and blunt implements

No precise use can be safely assigned to some articles with rounded or flattened ends. Those which are curved and slightly tapering were probably inserted in clubs. Others have purposely enlarged ends. If they had points, they might be considered pins, but usually these are lacking. It has been thought that some were used in décorating pottery, but a hollow bone seems the only bone article employed for this. In a general way it may be best to describe them simply as they are, unless there appear reasons for some special use.

Fig. 52 is an antler prong with a rounded point, found by Dr Hinsdale in Pompey, on the Sheldon site. It is safe to assume that this was used in a war club, as all of like character probably were. Many such forms will be left unnoticed.

Fig. 53 is usually termed a punch, without further suggestions of use. It gradually expands toward the larger end, which is neatly worked and almost flat. The smaller end is as neatly rounded, the general form being cylindric. This is from the recent site in Rice's woods, near Stone Arabia. Fig. 83 is a bone implement in the Waterbury collection at Brewerton. It suggests a small pestle, and is nearly square in section, having the edges and ends rounded. Fig. 87 is a Mohawk bone article in the Richmond collection, nicely worked and cylindric throughout. At one end the cylinder is abruptly enlarged, and both ends are neatly cut. Fig. 90 is a long and thick cylindric bone, which is unperforated. It is well worked, and the ends well rounded. It is in a Buffalo collection.

Fig. 91 is a very long cylindric bone punch, from the fort near Pompey Center. It expands slightly toward one end, and very much toward the other. Fig. 92 is a long, slender and cylindric bone implement, slightly curved. Near each end of the concave edge is a sharp notch. This is not perforated, and is one of four of various lengths, taken from a grave near Rochester Junction by C. F. Moseley of Bergen N. Y. The grave contained European articles. The other bone relics were shorter and thicker, evidently intended for beads but not perforated.

Fig. 96 is flat and thick, parallel sided, and with the ends nicely rounded. Dr Hinsdale found this at Brewerton, and with it two others, differing only in being shorter.

Fig. 97 may be a broken pin, having a thick and angular head. The general form is cylindric. It is in the Richmond collection, and came from Richmond Mills, Ontario co. Bone fishhooks were found with it. Fig. 99 is a cylindric bone, expanding into a broad, flat and curving edge. The small end is neatly rounded. It is from the recent site near Stone Arabia. Fig. 100 is a fine curved and cylindric bone pestle, found with a bone mortar at the Garoga or Ephratah fort, in Fulton county, by S. L. Frey. It is very neatly worked.

Fig. 103 is a short bone punch, cylindric, but expanding toward one end for nearly half its length. This is in the collection of F. H. Vail in Pompey Center, and comes from the fort, a little south of his house, known as the Lawrence fort. Fig. 112 is much like the last, but is longer, while the expansion is shorter. Some polished bone beads were with this, of the same diameter and average length. This is from the Atwell fort, and in the Bigelow collection. This form seems most common in the early historic period.

Fig. 131 is a cylindric and tubular horn implement, and may have been a charger for powder. The narrower projection at one end is an eight-sided stopper of horn. Found by Luke Fitch on a recent site north of Watervale in Pompey. Fig. 301 is a well worked cylindric bone, which is not perforated but may have been intended for a bead. It came from a grave at Rochester Junction. Fig. 297 is smaller than the last, but is of the same character and from the same place. The same may be said of fig. 298, which is much more slender than either. From their presence in a grave and nicely rounded ends, it may be inferred that they were finished articles, whatever their proposed use. Fig. 330 is a very neat cylindric punch, with the frequent neatly rounded ends, one of which is expanded. It is from Rice's woods near Stone Arabia. In the plate it is reduced in size, the true length being 3 inches.

Fig. 341 is a curious article from Brewerton, 9 inches long, but reduced in this plate. Dr Plato, the finder, thought it a tusk, but it is probably horn. For more than half the length from the rounded point it is cylindric; thence toward the base it is more quadrilateral, but with rounded edges. The base is abruptly and uniformly compressed, and has a long rectangular perforation. In Europe such holes were for holding stone points, but this does not seem the purpose here. The implement follows the natural curve of the material. Many curious things were found with this.

Fig. 346 is another curious article of deer horn, resembling the last in some respects but not closely. It is the lower part of an antler, retaining the base almost unchanged. All the prongs have been removed, and much of the surface dressed down. The tip has been cleft and sharpened where it was cut off, and toward the base is a rectangular hole, such as is found in the primitive bone whistle.

This and the last could hardly have been used as handles for stone points. It measures 7½ inches from tip to tip, and is nearly cylindric. This came from a grave at Jack Reef, on the Seneca river, and is in the Bigelow collection. A shorter prong was found with it.

A few other examples may be mentioned. One bone punch from the Atwell fort is almost elliptic in section. It is ⅜ of an inch wide and 2¾ inches long. From the same place comes a tapering but not pointed bone punch, which has the ends rounded, and is 2⅞ inches long.

In the Vail collection at Pompey Center is a cylindric and tapering horn punch, 5 inches long. Dr Hinsdale found a cylindric, slender and perforated bone at Brewerton, both ends of which were broken. It was 6¾ inches long, with an average diameter of a quarter of an inch. Another curious article is in the Waterbury collection. It is a slender, irregularly curved and pointed implement, 6⅜ inches long. There are transverse cuts near the pointed end, and rough and shallow grooves around most of the article. Dr Hinsdale also had, from the same place, a curved and cylindric bone, 4½ inches long. In W. L. Hildburgh's collection are many of the so called punches; and worked antler prongs occur on most village sites. One odd article in his collection is a curved piece of antler, 7½ inches long, which has notches toward the upper part of the convex edge. This came from Pompey.

Beads and pendants

Fig. 35 shows one of the birdlike pendants, which are perforated laterally through the neck. This is ornamented with dots and lines, and comes from Scipioville. They are more frequent in shell than in bone. Fig. 36 is another from Honeoye Falls, belonging to C. F. Moseley of Bergen. There are transverse lines on this, and the eyes are represented. Fig. 129 is from Pompey, and is ornamented with dots. All are of the historic period, late in the 16th and early in the 17th century.

Fig. 95 is a moderately long cylindric bone bead, highly polished, and well worked at both ends. This was taken out of ashes at the Atwell fort in 1896 by Rev. W. M. Beauchamp. It is a fine example of its class. On sites of that age bone beads share the

honors with those of shell, while others but a few years earlier may show only bone beads and ornaments.

Fig. 124 is a long, straight and cylindric bone bead, found in Pompey. It is polished and slender, and has transverse diagonal lines. Fig. 132 is from the same place, its outline being a long ellipse. It retains its polish. Fig. 136 is a large and cylindric bone bead from Pompey. It is a little curved, and the ends are well finished. Fig. 137 is a straight and polished cylindric bone bead from the same town. It is adorned with cross grooves. Fig. 138 is another cylindric and curved bead in the Waterbury collection at Brewerton. Long beads usually retain the curve of the bone, and the perforation may be unaltered or enlarged. Fig. 174 is a short, flattened cylindric bead found near the mouth of Perch river.

Fig. 139 is of a different character, and is from the fort near Jamesville, burned in 1696. It presents a rectangular outline here, but is triangular in section, and was made with metallic tools. It is in the Bigelow collection. Fig. 140 is a curious little ornament or implement from the Atwell fort, unperforated, though a slight depression may indicate a hole begun. It is foot shaped and indented, and is now in the Burr collection. Perforated articles, similar in form and size, have been used to keep open the slits in noses and ears. One like the figure here given was found in a mound on the Bay of Quinté, on the north shore of Lake Ontario.

Fig. 144 shows the end of a femur bone, worked and perforated for suspension as an ornament. This was found by Dr Hinsdale on the Sheldon site in Pompey. The outline is more elaborate and the perforation larger than in several examples from another Pompey site, a few miles away, and perhaps of 50 years' earlier date. Fig. 356 to 361 are all from the Christopher site, and in the Bigelow collection. Fig. 357 is a good example of the same ornament. It is partly smoothed on the reverse, and has a small perforation, like all others from this site. Fig. 358 has been ground smooth on the reverse. Fig. 359 is perforated through the natural depression, and smoothing has been begun on the other surface. Fig. 360 is made from the concave capping of a joint. The natural surface is here shown, slightly worked. On the reverse it is ground smooth.

The perforation is central. Fig. 361 shows the rough side of a similar plate, showing signs of use. The figure presents the convex surface. All these are of a deep brown color, which may have come from exposure or choice.

Fig. 356 is a broken but well wrought ornament, hard and white as ivory, and with a high polish. It is a carving of a bird's head, with a perforation for the eye. The lower edge is sharp, and ground from both sides. It is concave on the reverse.

Fig. 145 is a short and cylindric bone bead from Buffalo. Fig. 146 is longer and more slender, and was found in Cayuga county. It has transverse grooves and is recent. Fig. 147 is a black bone bead, discolored by lying in the water. It was found by Dr Hinsdale at the mouth of Chittenango creek, and is short, curved and cylindric. Fig. 158 is a short bead in the Richmond collection, from the Nichols pond site. Fig. 165 is a long and cylindric bead from Rice's woods, and is in the same collection. It has three groups of encircling grooves. Fig. 167 is a so called crescent from Venice, Cayuga co. These are usually of shell. In stringing they were placed close together, or separated by short beads. Fig. 276 is unique, and is in the Richmond collection. It comes from England's woods, where the caches are found northeast of Stone Arabia. It resembles the common bird forms except in its large size, and in having feet near the tail. Fig. 300 is an ovate bone ornament in the Buffalo academy of science, probably intended for perforation and suspension.

Fig. 347 is a flattened ornament, perforated from top to bottom, which would be triangular but for being cut off above. Fig. 348 is similar, but is almost pointed. In section each is a flattened ellipse. Several of these were found varying much in outline and size, but having the same general character. They were obtained 2½ miles north of Fort Plain.

Perforated and grooved teeth

Teeth and claws have been a favorite savage decoration all over the world, and the perforated bears tooth of Europe scarcely differs in appearance from that of America. There are probably very few village sites in New York where this is not found, cut, perforated or with a groove around the base. On camp sites of brief occupa-

tion these teeth can hardly be expected. The teeth of smaller animals were in less favor, though sometimes used. Human trophies perhaps had not the esteem which some have supposed. Fingers were cut or bitten off by the fierce Iroquois, but there is positive evidence that these were not preserved, as some have thought. Accustomed as they were to plucking out the nails of captives, it is not likely these were kept as trophies, as has been reported. The French often told such things, as the enemies of the Iroquois related them, and De Vries said that either the Mahikans or the Mohawks "place their foe against a tree or stake, and first tear all the nails from his fingers and run them on a string, which they wear the same as we do gold chains. It is considered to the honor of any chief who has vanquished or overcome his enemies if he bite off or cut off some of their members, as whole fingers." *De Vries*, 3:91. This, he was told, was done at Albany, which was in the Mahikan territory.

Father Jogues mentions the Mohawk practice:

There remained to me only two nails; these barbarians tore these out with the teeth, lacerating the flesh beneath, and stripping it even to the bone with their nails, which they nurse until very long. *Relations, 1647*

In the *Relation* of 1658 it is noted that the savages "nourish their nails as a mark of nobility, showing that their hands are not fit for work." A necklace of this kind might thus show the rank of those tortured or slain. Most narratives give the impression that they were torn out and cast away. In the nature of things they would not have survived to our day, if preserved then.

In a paper entitled "Medicine men of the Apache," Capt. John G. Bourke describes the use of perforated human teeth as ornamental trophies, in many parts of the world. He says, "In my own experience I have never come across any specimens, and my belief is that among the Indians south of the isthmus such things are to be found almost exclusively. I have found no reference to such ornamentation or 'medicine' among the tribes of North America." *Bourke*, p. 487

Human teeth occur on Iroquois sites unconnected with graves, for in their cannibal feasts these might be dropped anywhere, but perforated teeth are certainly rare. Fig. 162 is one from an Oneida

site near Munnsville N. Y., now in the writer's possession and attached to a string of small disk beads. It is perforated laterally at the base, and is in good preservation. In graves the teeth are usually the best preserved parts of the human frame.

Fig. 195 is another rare specimen from the Onondaga fort of 1696. It is the crown of a tooth neatly cut off and perforated for suspension, the hole being at one corner. The grinding surface is much worn, but it appears to be one of the lower side teeth of the black bear. This is in the Bigelow collection. Fig. 188 is a perforated tooth from Pompey, owned by Mr Fitch. A similar one was with it, and it is one of the front teeth of the woodchuck. Fig. 293 is much like the last, but has been cut down to a greater extent. It was found at Munnsville.

Fig. 178 is part of a beaver's tooth, split and then ground flat on the inside. It was found by Dr Hinsdale at Brewerton. Fig. 179 is another woodchuck tooth from the Christopher site, which is notched like a saw. Such examples are rare. Fig. 296 is another perforated and worked tooth of the beaver, found at Brewerton. It is of a red color and quite large.

Fig. 193 is an elk's tooth, perforated and ground off at the base. It is in the Richmond collection. It was found on the Otstungo site. Fig. 194 is another from Brewerton. The only work on this is the perforation. Several found there were perforated and more or less ground. Fig. 272 is from the Onondaga fort of 1696, and is in the Bigelow collection. Another elk's tooth with it was cut off at one end. Fig. 273 is a smaller tooth in the Burr collection, found on the Atwell site. It is quite dark in color, and one with it was opalescent. Fig. 274 is a smaller perforated tooth from a prehistoric fort a mile west of Baldwinsville and north of the Seneca river. It is in the Bigelow collection. Elks teeth were and are highly prized by the Indians, and now bring a high price. A few more will be mentioned later.

Fig. 294 has the appearance of a wolf's tooth, and is in the Buffalo collection, where there is another. Fig. 292 is similar and from Geneva.

Bears' teeth unworked are frequent; and out of a great number of those used for ornament a few selections are here made. They

occur on almost all village sites, and have a wider distribution than any other bone ornament in time and territory. Here there are three principal divisions: those grooved for suspension, those perforated, and those cut off for some other purpose. Fig. 286 is the common form of those perforated, the work being confined to the perforation as a rule. This is in the Vail collection at Pompey Center, and was found in 1894. Many of these have been figured. Fig. 316 is of a very large size, and was found by Oren Pomeroy in the vicinity of Chaumont bay. As it was evidently broken before being worked, it was probably the cherished trophy of some big bear fight. The base is indented and the perforation large. It is carefully worked all over, and every fracture is neatly smoothed off.

Those grooved for suspension show more variety, and yet require but little illustration. Fig. 283 is a tooth both grooved and much cut down. It has been split since it was formed, and is in the Vail collection. Fig. 288 is simply grooved, and is from Rice's woods in Montgomery county. They seem most abundant on recent sites.

Fig. 287 introduces us to a very interesting class of bears teeth. It was found by Dr Hinsdale on the Christopher site, and is merely cut off at the base, presenting a flat surface there. This site was probably occupied in the 16th century. Fig. 289 is unique, having a piece neatly cut out of the point, leaving it very sharp. This was found in 1899, on the north side of the river at Brewerton, and is in the Waterbury collection. Much of the surface has been ground and polished.

Passing from these, we come to the distinct class mentioned, where the base is sharply cut away nearly or quite half way to the point, exposing the cavity of the tooth. Fig. 143 is a good example, and was found by Dr Hinsdale at Brewerton, in or close to the grave where the walrus tusk implement was obtained. It was probably of a later date than that. Four large teeth and one smaller were worked alike. Fig. 290 is another of these. Fig. 291 is from the early fort west of Baldwinsville and north of the river, probably occupied in the 16th century. It is in the Bigelow collection, and is cut off in a different way. While this form is rare, it has been found on an early site in Ohio.

A few perforated or grooved teeth may be mentioned. A bear's tooth with a groove comes from the Atwell fort, and another with a narrow groove from lot 27, Pompey. One perforated at both ends is from Jefferson county, and thence comes another with the base rounded and the tip ground sharp. Another perforated example is from the neighborhood of Waterburg in Tompkins county. A large one is from Rice's woods. Mr Bigelow has a fine one from the fort of 1696, and a perforated deer's tooth from a fort near Baldwinsville. Raymond Dann has many from a site near Honeoye Falls. A perforated elk's tooth is from Munnsville, and another is in the Vail collection.

In the Hildburgh cabinet are good examples of all the forms mentioned. One is a good specimen of those of the bear cut off near the center, and is from a recent site a mile north of Lima N.Y. This would bring them into the historic period, but most seem a little earlier. Three fine and grooved bears teeth are from a recent site at Oneida Valley, and several perforated ones are from West Bloomfield. With these were perforated elks teeth.

Ornamental forms of bone

Unless some of the articles called awls were used for decorative purposes, bone and horn were but little employed in adorning the person. A few things have an ornamental character, but they are so few that they will not detain us long, as beads and pendants have already had attention and bone combs will be treated separately.

Fig. 105 is a fragment found by Dr Hinsdale on the Christopher site. The broader part is ornamented with long rectangles engraved in the bone, and the narrower portion with notches in the edges. It may have been a comb, but more probably was the handle of some implement. Fig. 106 is unique, and seems the upper part of a pin or awl. It ends with the head of a fish bent a little out of the plane of the handle, and below this is a broad band encircling the handle. It was found by the writer on the fort site before mentioned as west of Baldwinsville.

Fig. 150 belongs to Col. W. B. Camp of Sacketts Harbor, and was found on a point east of that place. There are four human heads at the top, and there is a deep cut at the base as though for the insertion of some instrument. The general character is that of

recent work. Fig. 151 is a curiously carved article from the Nichols pond fort. It is hollow and flat, being but ⅝ of an inch thick. The two hollows within are not connected. On the reverse and toward the point are three parallel elliptic openings into one cavity. By these it might have been attached to the apparel, or a blade might have been inserted in the broad opening at the other end. The reverse is quite flat. As this fort is identified with Champlain's expedition of 1615, there is a definite age for this carved bone. In some respects it resembles Eskimo bone handles, and probably was made with metallic tools.

Fig. 155 is from the Otstungo site and in the Frey collection, and may be compared with fig. 151. It has an owl face and elliptic openings on each side, and was probably a handle. Fig. 154 is also in the Frey collection, and is from a figure made by him. His description is brief: "A piece of antler decorated; cutting evidently done with a flint knife. Found at Garoga, August 1889, by S. L. Frey." The edges of the terminal opening are scalloped, and the straight grooves are variously arranged. The elliptic grooves are a novelty at so early a date, and with the tools probably used. It may have been a handle, but the ultimate design may have been a pipe. It is certainly fine.

Fig. 153 is one of three articles found at Union Springs, and is the smallest of the lot. The points of all are cut off. The longest is 4 inches in length, an inch broad at the top and partly scalloped there. Another is 3½ inches long, as wide as the last and with marginal dots. All are of thin horn, cylindric and hollow. This one is abruptly compressed toward the point, and has short marginal cuts at the broad end. The general form of all approaches a cone. In John Murdoch's *Ethnological results of the Point Barrow expedition*, p. 189 and 301, are some figures resembling these, but with well defined teeth of some length. They were called combs for deerskins. These could not have been used in that way, and more probably may have held charges of powder.

Fig. 157 is the broken, ornamented head of a pin or awl found on a fort site west of Baldwinsville, and now held by the writer. The reverse is a little differently carved. Fig. 310 is a broken article, apparently made from a moose antler. The form

may have been obtusely elliptic with broad notches or points at the ends. Dr Amidon found this in a refuse pit near St Lawrence village, and thus described it:

Part of a gorget, or some other article of adornment, made from — I should say — moose or caribou antler, because of its great breadth and flatness. Probably double-ended, i. e. symmetrical. Found only one end. On the back are two holes for suspension by a thong. The front is traversed by transverse lines, between which are decorations of a cuneiform character.

The two holes may have terminated in the interior cavity, as they converge, but may possibly have passed through to the frontal surface. It probably lacks but little of the original length and breadth, judging from the surface curves. The arrowheaded marks are peculiar, and in four rows. Another might have been expected, but there are no signs of this. The interior is now cellular, without signs of work. The general style is somewhat recent.

One class of grim ornaments has left some examples. The New England Indians were at first credited with taking the heads or hands of their enemies as trophies. The Neutrals of Canada gloried in the number of human heads they had taken. This may be understood literally or may refer to the scalps which they removed from the heads. However this may be, ornaments made from human skulls are sometimes found in New York. Fig. 141 is one of the best examples now known, and was in the Twining collection. It came from Rutland in Jefferson county, is nicely worked around the edges, and has nine perforations. Fig. 148 is a fragment found in Pompey. There are two perforations remaining, and part of a third. It is flat and thin. Fig. 149 is a perforated pendant of bone from Hemlock lake, Livingston co. N. Y. A photograph of this was furnished by Dr T. B. Stewart of Lock Haven Pa. The bone is much curved, and the figure suggests part of a skull.

Fig. 201 is also of a doubtful nature. It is a small oboval bone gorget, with one large and two small holes, and is slightly concave. It is a recent article from East Bloomfield, owned by Irving W. Coats. Fig. 202 is in the Vail collection, and comes from the recent fort near Pompey Center. It is a grooved, cut and perforated piece of human skull. A grooved fragment was found with this. Fig. 303 is a thick, flat and curved bone. The writer does not

remember whether it is a piece of a skull, as is probable. There is one very large perforation, and part of another intersected by one worked edge, showing that it was at first a larger ornament, which was broken and recut. The two worked edges are curved. This is black and light brown in color, and from the Atwell fort.

Fig. 333 is part of a perforated skull found by Dr Amidon in Jefferson county. It was evidently much larger, but a small part of the original curved and polished margin now remaining. There are now two holes, the one farthest from the curved margin probably being near the original center. In the plate the fragment is much reduced, the full length being $2\frac{3}{4}$ inches. Dr Getman has similar articles, one having an ornamented edge and several perforations.

Mr Twining reported some articles from the old Tamblin farm, in the town of Rutland, Jefferson co. and among these "an amulet, some 5 inches in diameter, drilled with seven holes, and cut from a human skull. The holes were undoubtedly made on the head of a living subject, judging from the appearance of the openings." He furnished the sketch for fig. 141, also from Rutland, but that is smaller and has more perforations. At another place in that county he found "two circular amulets with holes therein, from human skulls."

In the Brewerton cemetery Dr Hinsdale obtained a flat piece of bone, sawed so as to have six edges. The extreme length was $2\frac{3}{4}$ inches. In this was a large circular perforation, $\frac{3}{4}$ of an inch across. The ultimate design can only be surmised.

A very curious long skull was found in Cayuga county a few years ago, which was circularly perforated in an upper angle of the forehead, but not by drilling. The proportions were very remarkable, being 8 by $4\frac{1}{2}$ inches, and caused by pressure. The interior ends were rather smooth, and the sides strongly corrugated.

Among human bones may be mentioned a much flattened tibia, found in the grave with the walrus tusk implements at Brewerton by Dr Hinsdale. It is $8\frac{3}{8}$ inches long, $1\frac{1}{4}$ inches wide in the center and $\frac{11}{16}$ of an inch thick, which is a moderate form of platycnemism. Most of the bones in this grave were decayed. Fig. 336 is another human bone from the same place, which is worked at one end and the natural groove deepened. This is reduced.

J. S. Twining furnished the writer with several outlines of carved bone articles from Jefferson county, but the details were too few for reproduction here. Henry Woodworth, of East Watertown, has worked and perforated pieces of human skulls in his fine collection, and many of his bone articles have ornamental lines. Unfortunately he would allow no drawings to be made.

Fig. 111 appears to be a bone pendant, and was found near Munnsville. Provision for suspension has been made, and the point has been cleft. Fig. 85 is an open and ornamented bone, pointed like an awl, but possibly an ornament for the ear or nose. It comes from Buffalo.

Fig. 63 and 64 represent a type of bone articles from some parts of Jefferson county, which has been reported nowhere else. They are of various sizes, like a canoe paddle in outline, and with a knob at the top. Sometimes they are ornamented with engraved lines. The writer has seen them only in the Twining and Woodworth collections, and they seem purely local. Since writing this he has examined a fine one found in the summer of 1901 by Mr Pomeroy, at Storrs Harbor, Jefferson co. It is flat and thin, and 5 inches long. At the same place Mr Pomeroy got a fine clay pipe bowl, with a human face before and behind.

Fig. 130 may have been intended for an ornament, possibly a pendant. It is perforated for suspension, and compressed at that end, but was probably used for receiving charges of powder. It is recent of course, and was found in Fleming. The material is horn, and is quite thin.

Fig. 56 may properly be called a bone pin, having a thin and flat head, and a point which is moderately sharp for so thick an article. The diameter is but half as much the other way. Bone pins with distinct heads are very rare, though one example may have been already noticed. Dr Hinsdale found the one here described at Brewerton.

Fig. 278 is reduced from Schoolcraft's great work on the North American Indians, and shows a long and slender pin of polished bone, found in 1835, in excavating at Fort Niagara N. Y. It is 10½ inches long, ⅛ of an inch thick, and is somewhat curved. The head is bifurcated, and has two short hooks on each side. He

called it an awl, for which it is unnecessarily long and slender, and there can be little doubt that this fragile and well preserved article was an ornamental pin.

Bone images and masks

Artistic results in bone carving could hardly be expected before the Indians had metallic tools. So, when a well worked face or head appears, it is natural to infer the use of these, even on what seem prehistoric sites. Fig. 177 is a finely made bone face, with a narrow and rudely worked projection beneath. On each side are half circular notches where the ears should be, and there is a partly drilled hole in the back. This is interesting from its age, being from the early Cayadutta site, where but one recent metallic object has been reported. It is probably not far from 300 years old, and is in the Richmond collection. The work suggests the use of metallic tools.

Fig. 156 is in S. L. Frey's fine local collection, and came from the Otstungo fort, always classed as prehistoric by working antiquarians, though Mr Squier was told that European articles had been found there. It is a well carved bone head, and the helmet-like headdress and possible moustache suggest some knowledge of Europeans. Some other articles from this site hint at the same thing. If made with stone tools, it is certainly very remarkable.

Fig. 152 is a well wrought bone head from the Onondaga fort of 1696, and was probably made with European tools. It is in the Bigelow collection, and was worn as a bead, there being a single large perforation from top to bottom. Usually there are more perforations in such objects, to insure the face's turning outward. For this purpose there are three small holes for suspension in fig. 175, which is in the Hildburgh collection. It is a small and neat bone mask, with a projection above and below. This is from a recent site at West Bloomfield, and is much like some stone ornaments of about the same age.

The remaining figures of this class are full length bone images. Fig. 169 is from Honeoye Falls, and is in the Dann collection. It is a large, flat human image of bone or horn, unpolished and unbroken. It has much the character of the bone combs so frequent there, but seems complete in itself. Fig. 170 is a bone image of a

small child, smoothly carved. It is from the Mohawk valley, and in the Richmond collection.

Fig. 171–73 are from drawings of three bone images in the state museum, made by R. A. Grider, and much like Canadian examples. All come from West Bloomfield, and are light brown in color. Fig. 176 is the largest bone image yet found here. It was found in a grave of an adult and a child, which contained bone beads and some copper wire, and belongs to S. W. Morse of Willow Point N. Y. The back is much weathered, and there are longitudinal cracks. There is a prominent headdress, probably representing the symbolic horns of an Indian chief.

A finely carved head, terminating a piece of deer horn, comes from an Indian site at East Aurora. It is of very recent character. In the deep ashes of a fireplace in the Genesee valley, a beautifully carved Chinese head of ivory was found, which must have come there in the way of Indian trade. Prof. G. H. Perkins of Burlington Vt. has a fine bone mask from the northern Vermont line, closely resembling some small stone masks of New York. All such articles are of recent date.

Bone combs

The Indian use of bone combs seems not very old, and yet is prehistoric in a sense. Most of those found are of the 17th century, but some seem a few years earlier, suggesting a knowledge of Europeans without direct contact. The early ones are very simple in design, and with few but strong and large teeth. They are almost entirely confined to Iroquois sites, or those classed with them. Out of a large number a few forms are given here of both periods. All those in Jefferson county, and a very few elsewhere, may be called prehistoric.

Fig. 186 is one of these early forms from Jefferson county. It has scalloped edges and some elliptic perforations, and the four large teeth are all broken. Fig. 187 is from a drawing furnished by Mr Frey. The type is early, though from a recent Mohawk grave. There are but four teeth, and the upper part of the comb is highly ornamented. The article is perfect and fine. Fig. 196 is from an early Onondaga fort of the historic period, on lot 100, Pompey. Three teeth remain, but another seems to have been

broken off while in use, as the fracture has been ground down, leaving only the notch. There is a large perforation near the top, opposite which is a sharp notch on either side. There is no distinct ornamentation. Fig. 198 is a fine broken comb from Hemlock lake, Livingston co. N. Y., and belongs to Dr Stewart of Lock Haven Pa. One of the large and long teeth has been broken off. In the small upper part there is a large circular central perforation. Fig. 199 is from the Atwell fort. This also has three teeth, and there is an elliptic perforation near the top, with grooved lines. Fig. 200 is from the same site and in the Burr collection. There are four teeth and 11 perforations. Both these are of the simple early forms. There are good examples of these in the Woodworth collection. Fragments of some plain combs have been found at the Lawrence fort near Pompey Center. In the Richmond collection are some rude perforated and unperforated plain combs, but their width and the number of teeth at once show their recent date.

A plain, broken and double comb has been ascribed to the Atwell fort. The location is probably erroneous, as it has many teeth, and its general character is too recent for that place. It certainly was made with metallic tools. In the state collection is a large bone comb from Genesee county, which has three teeth and is 8½ inches long. It has a human figure in the upper part, but the general type is early. There are lines and openings about this figure, and above and along one margin are small circular perforations.

The figures which follow are of the historic period, and are mostly symmetric. Fig. 180 has two men facing each other in combat, and is perfect. It is broadest at the top, where the corners are neatly rounded. This is from Scipioville, Cayuga co. The Cayuga specimens were found by W. W. Adams, but have gone into several collections. Another of these has two serpents in a similar position.

Fig. 181 is unsymmetric, and the teeth are mostly gone. It is from Honeoye Falls and in the Dann collection. A bird faces a man, and is of about the same hight. The bird's bill was probably joined to the man's shoulder. Fig. 182 is also unsymmetric, and was found at Rice's woods. It has a lizard above, the long tail

hanging down one side. Below this are lines in various directions. But two of the teeth are broken. They are many and short.

Fig. 183 is from a grave at Rochester Junction, and belongs to C. F. Moseley of Bergen N. Y. It is perfect, and two birds form the upper part, their long bills meeting. Fig. 184 is a fine comb from the McClure site in Hopewell N. Y. Most of the teeth are broken, but the upper part is entire. This has a perforation in one upper corner, and there are several figures scratched on the smooth and broad surface. It may have been unfinished. It was found in 1890. Fig. 185 is unsymmetric and large. A man behind a horse, and one on it form the principal design. This was found in a young woman's grave in one of the Seneca villages burned in 1687, at Boughton hill near Victor N. Y., by Dr A. L. Benedict of Buffalo. The teeth spread, and nearly half are gone. The skeleton in this grave was of a person about 18 years old, and was buried in a reversed position, the head down and feet above. In the graves were a brass kettle, traces of a basket, about 12 feet of French glass beads of several colors, 20 feet of red glass beads, about 35 feet of council wampum arranged for a belt of five or six rows, and seven long shell beads. Besides the comb, there was also the skeleton of a turtle.

Fig. 189 shows a bear at the top of a large comb, and is in the Dann collection. The teeth are badly broken. Fig. 190 is a recent, fine Mohawk comb in the Richmond collection. There is a large arched opening above, and this and the outer edges are notched. Fig. 191 is a long, rectangular and flat bone in the same collection. It has a circular perforation at one end, and regular notches at the other. Mr Richmond thought this a pottery marker, but pottery has no even and regular lines, and it was probably begun for a comb.

Fig. 192 is a fine comb with about half the teeth remaining. Two turkeys, separated by a central post, have a circular ornament above their heads. This is from Fleming, Cayuga co. Fig. 197 is of a similar character and from the same place. Two partridges are fighting. Usually the space below is plain; in this case lines are regularly arranged in various directions. Fig. 337 is the longest comb which has met the writer's eye. It is slightly broken in

places, but the defects are not serious. Two quadrupeds — probably wolves — are rampant, and their upturned mouths hold a serpent's head. The short, plain space beneath them has a horizontal line of circular perforations, and the teeth are nearly perfect. This very fine comb is from Honeoye Falls, and in the Hildburgh collection. The length is 10¼ inches, and the teeth are 1¾ inches long. It is much reduced in the plate. The owner kindly furnished blue prints of his relics. In Mr Hildburgh's collection are three other good examples, all somewhat broken, and all from the same site as the last. One has a man standing behind and probably laying hold of a rampant animal whose head is gone. One has two bears rampant, and in this only the teeth of the comb are missing. Another has an animal standing with the head turned back over the shoulder. The teeth and tail of this are broken.

A few others may be mentioned. The writer found a broken one at the recent site overlooking Wagners hollow in Montgomery county. It had teeth at both ends and two perforations. This was in 1889. On the same spot he found a thin, flat bone, nearly square and well dressed, the front and edges being smooth. It was 2½ by 2 inches. Slight cuttings had been made at one end, preparatory to forming a comb. On the same spot were copper saws used in this work. A straight piece of sheet copper was selected, and fine teeth were cut in this with a file, making a serviceable implement.

In the Richmond collection is an unfinished comb from Rice's woods, which has a central perforation, short teeth at the broad end, and three notches at the narrow.

In the Dann collection are a number of combs, and among them is an unfinished one of much interest. The teeth have been finished and afterward broken, and the full outline has been formed. There are two excavations and some lines. The unfinished design seems to have been that of two turkeys with raised heads. It is interesting as showing that these were actually made in Iroquois villages of the last half of the 17th century. Two of these have quadrupeds rampant, two on each comb. Another has two birds, and still another two bears in the same position. One has a human bust, and all are more or less broken.

It is curious that, while so many have come from the old villages

of the other four nations, not a single specimen has the writer seen from an Oneida village, and but one broken specimen from the Oneida territory, which is double as regards teeth. They must have been used by the Oneidas with the other Iroquois, and probably some have been found. It suggests the danger of rash conclusions from negative testimony. What has not been reported or found, may have existed and been used.

Pipes

It is barely possible, but hardly probable, that pipes of bone and horn may sometimes have been used in prehistoric times. These materials are combustible in a limited degree, and the burning tobacco would certainly have had a new flavor in a bone pipe, while the latter would soon have lost form and substance. This difficulty was obviated, at a later day, by lining the bowl with a thin sheet of metal. The question then arises whether any early article in the form of a pipe bowl did not have some other use. But for this action of the burning tobacco on the bone, there would be no hesitation in calling fig. 204 the bowl of a pipe. It is hollow within, and has a lateral perforation near the base, just as in pipes of which there is no question. For these reasons it is temporarily placed here, though its proper position may be with the bone whistles, which it resembles in form. It is four-sided, nicely worked, and has a human face scratched on one side. In fig. 203 the lateral perforation is near the broad end, and the larger cavity goes through the bone. No one will hesitate to call this a whistle or tube, though so near the last in appearance. The one before described is from the Atwell fort; this is from the Christopher site.

It has been suggested that fig. 154 may have been designed for a pipe but not completed, and this would be the writer's opinion but for this manifest difficulty in early use. In the state museum, however, is a bone pipe procured by Mrs H. M. Converse in Canada. The Indians there considered it an antique, but it clearly is a modern form. The metallic lining has disappeared, and it seems to have been used after this. The spiral grooves which held the metal in place still appear. On the top of the stem are nine crosses which were made by one hand, and are not mnemonic. It is a rare article, however, even in a modern form.

Fig. 159 is a very fine example of a pipe made from a large antler, which belongs to the writer, and which is probably a little over a century old. It retains the metallic lining in the bowl, without which no pipe of this material could be used. Its history is a little obscure, but it belonged to an early Onondaga pioneer, and was probably made by an Indian of that county. All the prongs but the basal have been cut off, and the bowl is in the cavity between that and the main branch. The carved lines have been filled with red or blue paint, and the holes and some other parts are edged with red. There are numerous perforations, as may be seen. The antler was split from the tip down to the bowl, and the unpolished side painted with Indian red. The stem is made of some light wood, with five encircling bosses, inserted in the stem hole at one end, and tied with buckskin near the other. This is about 14½ inches long, the figure being one half the actual dimensions each way. The chord of the arc of the antler as it is, is 11½ inches. The antler was an extremely large one of the Virginia deer. It is a very fine article, and probably absolutely unique.

For the reasons given, bone and horn pipes are among the rarest of Indian articles. That they might have been used 250 years ago is not impossible, but probably all made 150 years ago could be counted on one's fingers. There is probably not one existing for which a date so early can be verified. In speaking of one in the Toronto collection, Mr Boyle said: "Pendants and even pipes were made from bone. The last class of bone objects, it should be said, is very seldom seen. Only one has come into our possession so far, and it may have been a makeshift." *Boyle*, p. 76. This is a hollow bone, about 2¼ inches long, with a central perforation in the side.

Chisels and gouges

Fig. 13 is a small bone chisel, the locality of which is not certain. It probably came from the Atwell or the Nichols pond site. It is sharpened at the broad end and was in the Ledyard collection. Fig. 94 is a bone chisel from the Mohawk valley, and is in the Richmond collection. It is thick and broad, and is sharpened at both ends. Fig. 93 is like a chisel in general form, but the ends

are not sharp. It is well worked and nearly square in section. This is in the Waterbury collection at Brewerton.

Fig. 340 is a long bone gouge from the Atwell fort. A little of the top and most of the base are gone, but it is still 7¾ inches long, being much reduced in the plate. There was probably a point at the top, as well as a cutting edge at the broad end. Fig. 86 is a long and curved bône implement, naturally grooved, but having a perforation at the flat end. It is but slightly worked, but may have been intended for a gouge. It was found by Dr Hinsdale at Brewerton. Fig. 267 was also found by him at the same place, one piece being obtained by him in 1897, and the other the following year. It is made from a walrus tusk, and another implement was found of the same material, which also occurs north of Lake Ontario and the St Lawrence. The gouge is rather rude.

A figure should have been given of a broad bone gouge found by Mr Frey in the graves at Palatine Bridge, and figured and described by him. It is 4½ inches long and 2 inches broad, and is unusually fine.

Arrowheads

It is the custom to call hollow bone or horn points arrowheads, and they would have served this purpose very well by fitting the shaft into the cavity. Such articles are widely distributed, but nowhere abundant, and could have been used in this way only in exceptional cases. This may be qualified by saying that, if lost in the woods, they would not be preserved, and, however plentiful they might once have been, they would not endure like those of stone. The probability is however that as well finished articles they were little used.

This is not the only form of bone or horn arrowhead. Occasionally we find those made for insertion in the shaft, but these are much rarer than the form just mentioned. Very few have been found. Early writers on America testify to the frequent use of bone, and it is very likely that some things, naturally sharp, were used with little preparation. A merely splintered bone at close range would be very effective. A better point would be needed for a long shot.

In the *General historie of Virginia*, by Capt. John Smith, it is

said, "Their hookes are either a bone, grated as they noch their arrowes, in the forme of a crooked pinne or fish-hooke, or of the splinter of a bone tyed to the clift of a little sticke, and with the end of the line they tie on the bait. They vse also long arrowes tyed in a line, wherewith they shoote at fish in the rivers. But they of Accawmack vse staues like vnto Iauelins headed with bone. With these they dart fish swimming in the water." *Smith*, p. 31

Here we are to understand that the long arrow, used in fishing, had a line attached to prevent its loss, while some Indians used a longer and stronger handle, requiring no such precaution.

At a later day John Josselyn said much the same in his *Account of two voyages to New England.* Some fish the Indians took in the harbors, "striking them with a fisgig, a kind of dart or staff, to the lower end whereof they fasten a sharp jagged bone (since they make them of Iron) with a string fast to it, as soon as the fish is struck they pull away the staff, leaving the bony head in the fishes body, and fastening the other end of the string to the *Canow*." *Josselyn*, p. 140

The account suggests the barbed and perforated Iroquois harpoon.

Before considering the many types of the barbed bone harpoon, a few examples may be given of the simpler arrowhead.

Fig. 12 is a good example of the hollow bone point, found by Dr Getman at Perch river in 1899. This is nicely ground and sharp. Fig. 14 is a much larger size, and is of partly polished horn. Like the last, it is nearly cylindric. It was found by Dr Hinsdale at Brewerton. Fig. 22 has been noticed, but some consider this type as arrow points. This is not the writer's opinion.

Fig. 77 is a rare form from the McClure site, Hopewell. It is a triangular bone arrow, with indented base and broken point. The compression of the base serves a double purpose, to sharpen the barbs and affix the shaft. Fig. 78 is from Oneida Valley, and is in the Hildburgh collection. It is thickest in the center, and is not a frequent form. Fig. 79 may be provisionally placed in this general class, since it is hollow and pointed, but the large perforations add new features. These are not opposite, nor is the base cut straight across as in the arrowheads. Its size is another thing, and it may

have been intended for a dagger or spear. It is from the Minden or Otstungo fort and is of horn. Fig. 108 is another fine example, smaller, but having much the same character. The base is neatly cut across, but is now gougelike on one side. The implement is of hollow horn, quite sharp, and perforated from side to side. It is not highly polished, and the natural grooves remain at the base. This was found at Brewerton by Dr Hinsdale.

Fig. 304 is a broken and triangular arrow, much like those of flint. It is perforated in the center, has an indented base, and is irregularly worked. Of course it is not hollow. This is from the Atwell fort, and in the Burr collection. Fig. 311 is a horn arrow point, hollow and chipped, and with an indented base. It is in Dr Amidon's collection. Fig. 314 is in the same cabinet, and is also hollow and chipped, but of small size. The base is indented, and the figure might pass for one of flint. Fig. 318 also belongs to Dr Amidon. It is triangular, and both the long edges are sharp. On the reverse it is concave. Dr Getman found a flat and triangular bone arrowhead on the St Lawrence site, Sep. 21, 1901. It is 1¾ inches long and has an angularly shouldered base.

Fig. 323 is a fine hollow, cylindric horn arrow, sharp and polished. It is from an early site near Clifton Springs, and is in the Coats collection. Fig. 345 is a notched horn arrow from Rice's woods. It is rounded, not hollow, and the point is a little bent and obtuse. Most of these arrowheads are of horn.

Fig. 73 is probably a flat bone arrow, of a long, pyriform outline and indented at the base. It is grooved on one surface and merely notched on the other. This polished article was found in the ashes on the *Kaneenda* site, on the Onondaga inlet. In the Waterbury collection is a hollow bone arrowhead, 1⅝ inches long. There is another of these from Clifton Springs, in the Coats collection, and Dr Amidon has a fine one 2½ inches long.

W. L. Calver reported one of these at Cold Spring, Putnam co., and 20 others from a grave on Staten Island in 1895. He also had a hollow horn arrow from a shell heap at Spuyten Duyvil creek. Similar forms are found abroad.

A bone arrowhead from Hochelaga, at Montreal, is figured by Sir J. W. Dawson in *Fossil men*, p. 135, which closely resembles

the one in the Hildburgh collection. As Hochelaga was an Iroquois village less than 400 years ago, its articles closely correspond with those of New York.

Harpoons

Few early articles of bone or horn were more widely used than harpoons of various forms. Dr Charles Rau ably discussed and illustrated these in his *Prehistoric fishing.* One remark of his made as late as 1884 may well be quoted here, to show how important have been the acquisitions of the last few years. One barbed hook only had been reported then; now we have many, and the gain in harpoons has been yet more surprising, for most of these are older. Dr Rau said:

Considering that bone, on account of its toughness, was an excellent material for pointing fishing darts, the comparatively small number of old bone heads thus far discovered in the United States would be surprising, if their scarcity could not be accounted for by their frequent loss in the water. *Rau*, p. 142

That they were lost in this way is certain, for they are sometimes found in the water now, but their destruction by small animals and their rapid decay when away from preservative materials may be more important factors. That more had not then been found was also partially due to imperfect modes of search. Dr Stewart of Lock Haven Pa., in a letter to the writer says of a harpoon found near the Susquehanna river, "It is the only point of bone found in this valley to my knowledge." Yet there are earthworks and village sites in Pennsylvania where the spade might be expected to reveal many. This is a matter to be tested.

Out of 28 bone harpoons figured by Dr Rau from the United States, 16 were from New York, and five from Onondaga county. Several came from the northwest coast. A. G. Richmond in a letter to the writer under date of Nov. 8, 1897, observed:

I think Dr Hinsdale is doing remarkably. He has an immense number of things in the way of harpoons; the most I ever saw anywhere. I thought I was rich in the harpoon business, but he certainly goes away ahead of me. His are entirely different from mine. Mine are the one-sided ones, one, two and three barbs, all quite large; about 7 or 8 inches long and 1 inch wide. We don't seem to find the double-barbed pieces here. There is one place at Wagner's hollow, where I took you, where a great many of those large, flat harpoons are found. Some of them are broken, but mine are quite perfect and very good indeed.

The site mentioned is a recent one, and the form is that generally used by all the Iroquois in the 17th century. Dr Hinsdale's were mostly earlier forms, collected at two places, though he had them from other sites. A. H. Waterbury was equally successful in collecting at Brewerton. From these and other sources the writer has selected many fine, unique forms, much regretting the neglect of others.

Most European harpoons have larger barbs than those in America, and the Alaskan and Eskimo harpoons are perforated, like many recent Iroquois specimens. One from a mound in Manitoba has barbs only on one side. Eastern forms are found more or less in the western states, but those of California are more like those of Europe. Till very recently most of our bone articles were from California, a fact apparent in the national museum. The Toronto collection is much like that of New York, and the harpoons are the same. Harpoons seem rare in Ohio, but are found on the Madisonville site, which so closely resembles those of the early Iroquois. Its earthenware, however, differs greatly from that of New York. Bone implements are rare in New England, except in the shell heaps of the coast, but some double barbed harpoons have been found on Lake Champlain.

In New York bone harpoons are most abundant where the early and later Iroquois lived. Few have been reported west of the Genesee river, and along the Susquehanna and Delaware they seem unknown. The Hudson river and Long Island seem as barren. Dr D. S. Kellogg says that on Lake Champlain, "bone awls, punches and harpoons are found only in connection with broken animal bones and other remains in some of the fireplaces." These are in the early Iroquois territory, and thus the bone harpoon here seems limited to the drainage of the St Lawrence. Farther explorations may be expected to extend the area. In point of time it is both an early and recent article, with indications of continuity of use over but a brief period. At one time it seemed probable that those with double lines of barbs were much earlier than the larger forms, but both have now been frequently found on sites not four centuries old.

In the following descriptions harpoons will not be classified farther than the natural division of barbs on one or both sides. Both have

been found on the same sites and in the same graves. This is the case in Europe. Among the harpoons of the lake dwellers in Switzerland are those barbed on one and both sides. A Scandinavian specimen has barbs on but one. In New York, as a rule, this is a recent form when of a large size.

Fig. 234 is in the Bigelow collection, and is from a grave at Jack Reef on the Seneca river. In this were stone implements, two jawbones of dogs, and a flattened cylindric bone implement. There were also several double barbed ones. Fig. 238 is from the Richmond collection, and is a large and broad harpoon, with a central perforation and but one barb. Its striking feature is a series of short incisions at the base. Mr Richmond thought these were for marking pottery, but thongs of sinew might have been passed through them for attachment to the staff.

Fig. 239 differs widely from the last, and is in the Bigelow collection. There are nine large barbs on one side, and none on the other. The edges are nearly parallel and the barbs long. It came from the bank of Seneca river, north of Weedsport, and is dark brown, like most articles from that place. While generally well preserved, it is cellular on the reverse side. Fig. 242 is in the same collection and of much the same hue. It is from a recent fort partly on lot 8, Fabius, and is much curved the other way. There is but one barb, and no perforation. The lower part is abruptly expanded, as in some Seneca harpoons, and the edges are rounded, the general surface being flat. The barb is sharp and long.

Fig. 243 is a large and curious harpoon, much like a broad knife in outline. In one edge near the base is a large rounded notch, with a perforation lower down. The barb is so far from the point that it may be a knife, or at least have had a double use. It is from the north side of the river at Brewerton. Fig. 244 is of a very different character, and is in the Bigelow collection. It was found on Howland island in the Seneca river, and is triangular in section and highly polished. There are five barbs on one side, but what should be the point is obtuse, while the other end is slender and sharp. Dr Rau has an illustration of a slender one-sided harpoon used in arctic America, in his fig. 98, and describes its use. He quotes from Prof. Nilsson's *Primitive inhabitants of Scandinavia*, p. 33:

On the top of a long pole are fastened two tolerably long sharp-pointed bones, the tops bent a little outwards and the inner side provided with teeth pointing backwards, to hold the fish securely when struck. These bones are fastened to the shaft in such a manner that each, independently of the other, is in some way movable inwards and outwards; their sides are therefore flat at the other end, and the inner edge provided with one or more teeth pointing forwards, in order to be tied fast, so that they can not be torn away by the fish; and, in order to prevent their being bent too much apart, they are tied together by means of a strap at a short distance from the handle.

No long unilateral harpoons have been found here with these basal teeth, nor are they as long as those described by Prof. Nilsson. He adds that "the bone points, in all 11 inches long, are, to a length of 5 inches, fastened to the shaft, and consequently protrude 6 inches beyond it." It was his opinion, too, that these implements were not for spearing fish, but for shooting birds on the wing.

The Canadian Indians used something similar in early days, replacing bone or horn with iron when this could be had. The eel fishery was then of large proportions, and the *Relation* of 1634 describes the spear used in this:

This harpoon is an instrument consisting of a long stick, three fingers thick, to the end of which they attach a pointed iron, which they arm on each side with two little curved rods, which come almost together at the end of the iron point; when they come to strike an eel with this harpoon, they pierce it with this iron, the two sticks adjoining, yielding through the force of the stroke, and allowing the eel to enter; after this they contract again by themselves, because they were opened merely by the shock of the stroke, and prevent the speared eel from escaping.

The description of spearing eels by night, by Indians in lighted canoes, is precisely like that given by travelers in New York a century ago. Le Jeune adds that "some will catch three hundred, and many more, in a single night, but very few at other times." The French accounts of fishing at Onondaga lake far exceed this estimate. When they were there in 1655, Father Dablon said "some take with a harpoon as much as a thousand in a single night;" but then the size of fish stories is proverbial.

Fish weirs were quite generally used by the Indians, not essentially differing from those of the whites. David Zeisberger mentioned six of these between Oneida and Cross lakes in 1753. They

were all owned by the Onondagas, though the Oneidas made a claim to one or two of them at a later day. In the unpublished journal of that year Zeisberger tells us of his going from one to another on the Seneca river, Aug. 27. At the eastern one an Onondaga chief explained to him how the country was divided. He adds: "It is plain to be seen that they have much order in all their affairs. For instance, each one has his own place where he is permitted to fish, and no one is allowed to encroach upon his part. A chief is appointed to each fishing place, and he has his people who belong to him." This was necessary, for all parts of a river were not suitable for weirs and harpoons.

Fig. 245 is a harpoon in the national museum in Washington, much reduced, and is here taken from fig. 230 of *Prehistoric fishing*, where it is thus described:

A fine single-barbed harpoon head of elk horn, in an excellent state of preservation. It measures nearly 10 inches and a half in length, and has a thickness of about half an inch in the middle. The broad lower part shows two shoulders, but its base, instead of being worked thin, is more than ¼ of an inch thick. The head, nevertheless, may have been detachable. This specimen was presented to the national museum, with other valuable relics, by the late W. M. Locke, of Honeoye Falls, Monroe co., N. Y. His son, F. M. Locke, of Rochester, N. Y. informed me by letter that he had found it himself about two miles south of Honeoye, on the old Indian reservation called the Ball farm. "It lay on the surface where there had been a great many camp fires, and the clayish ground was covered with ashes, preserving the spear and other relics that might have decayed, had it not been for the ashes and clay."

Fig. 247 is in the Bigelow collection, and is a rare form from the Atwell fort. It has one long barb, and is much expanded above the base. It has a high polish, and is obtusely pointed at the base also, which is a rare feature. Fig. 249 is in the Frey collection, and comes from the Garoga fort in Fulton county. It is remarkable in being very slender below the barb, which is long and sharp. Fig. 250 is a long, curved and curious harpoon found in Cayuga county in 1889. There are two barbs on one edge very near the point. Fig. 254 is in the Coats collection, and is an early harpoon found near Clifton Springs. It is of a brownish hue, and has one long and sharp barb. One surface is ridged, and the whole implement is well wrought.

Fig. 259 is a curious example, found by Dr Hinsdale on the north side of the river at Brewerton. The general form is that of a broad and polished knife, pointed at one end and rounded at the other. The edges are rounded. There are two broad barbs on one side, and one narrow. The latter is not sharpened like the rest, and is formed by a half elliptic notch. The implement is broadest toward the point.

Fig. 268 was found at the mouth of Chittenango creek by Dr Hinsdale, and is blackened by lying in the water. It is a small and neatly made harpoon, with two small, dull barbs near the point. It is widest in the middle, tapering regularly toward the ends. Fig. 329 is as large as the last is small, but is much reduced in the plate. The length is 7¾ inches. It is from Rice's woods, and has a large perforation and two long barbs. It is a good example of the later Iroquois harpoons. These sufficiently show this class, but a few others may be noticed.

A large broken harpoon, with one barb and perforation, is 7½ inches long, and comes from the Atwell fort. A recent fine harpoon was found on the site of East Cayuga in 1888, by W. W. Adams, and has appeared in print. It is stained red, has two barbs on one side, and the edges protrude near the base. It is 4¼ inches long, and is shown in fig. 354. In the Richmond collection is a massive unfinished harpoon from the Garoga site. It is 6¾ inches long. In the Frey collection is a broken single-barbed harpoon from the Otstungo fort. In the Vail collection is one which is unfinished and large, being 7¾ inches long. The notches had been begun. In the Waterbury collection is the head of a large unilateral harpoon, with one large and prominent barb. The length is conjectural. Dr Hinsdale found a curious broken harpoon on the island at Brewerton, which seems unfinished. The four barbs on one edge are very distinct, but their thickness on the outside is about the same as that of the whole implement. They have not been sharpened in the least. In the Hildburgh collection is one which is rude and broken. It is 7 inches long, and has six barbs on one side.

Fig. 240 in *Prehistoric fishing* is of a New York harpoon. Dr Rau said of this, p. 150:

A harpoon head of deer horn, tolerably well preserved but unfortunately broken at the lower extremity. The point and the two barbs are carefully finished; the perforation, sunk in from both sides, is of irregular form. A cross-section above it would form an elongated ellipse with a shorter axis of nearly half an inch. Found by Mr F. H. Cushing in a shell heap in Onondaga county, New York.

Dr Rau goes on to say:

It probably has been noticed that these pierced dart-heads have all unilateral barbs; those with barbs on both sides, it will be seen, are not perforated, but may also, in part at least, have been detachable. Perhaps it is only owing to accident that none of the bilaterally barbed heads at my disposition is perforated.

This is the writer's experience in the examination of a great number of specimens. But one bilateral harpoon has been submitted to him with a perforation, and of this he had at first some doubts from other unusual features.

In E. G. Squier's *Antiquities of the State of New York*, p. 124, is mentioned "the point of a fish spear, made of the ulna of the deer; found in Livingston county." This appears to be the harpoon which has long been in the state museum, and credited to Avon. It is about 5½ inches long, has two barbs on one side, and a half-circular notch in each edge toward the base.

A somewhat rare form of harpoon has the ends alike, with barbs pointing both ways. The natural thought would be that this provided for accidents. If one end were broken the other might be used. Another purpose has been suggested, to which this might be contributive at least. In *Cave hunting*, p. 111, W. Boyd Dawkins figures a double-pointed harpoon from the Victoria cave, Yorkshire, Eng. There are three barbs on each edge, but two of these turn one way, and the other in an opposite direction. Of this implement Mr Dawkins said:

The harpoon is a little more than 3 inches long, with the head armed with two barbs on each side, and the base presenting a mode of securing attachment to the handle, which has not before been discovered in Britain. Instead of a mere projection to catch the ligatures by which it was bound to the shaft, there is a well-cut barb on either side, pointing in a contrary direction to those which form the head.

But few examples of this form have been found in New York, and but one has been reported in Canada. Fig. 235 is the smallest

which has come to the writer's attention, and this was found by Dr Amidon at the St Lawrence site in 1899. Both ends are pointed. At one end there are two barbs on one edge, and one on the other. At the other end there are three barbs on one edge, and two on the other. One edge has thus three barbs, and the other five. It is expanded in the middle. Dr Amidon found a larger one, on the same site, Sep. 21, 1901. It is 4½ inches long, and has three barbs on each side at one end, and four barbs on each side at the other. Thus far they have been reported from two places only.

Fig. 232 has lost both points, and may have been broken quite near these. At one end a barb remains on each edge; at the other there are two barbs on one edge, and there is one on the other. These are quite sharp. The flat surface is beveled at the edges. This is in the Waterbury collection, and was found at Brewerton. Fig. 263 was found at Brewerton by Dr Hinsdale, and is a perfect specimen, suggesting the use of the more distant barbs for attachment. At one end the bone forms an expanded angular head, with two barbs at some distance from this. The other end may be the true or primary point, with several barbs close to it. The upper side is mostly the natural surface, but the lower surface has also been smoothed. Fig. 321 is another fine example in the Waterbury collection, of which the lower side is here shown. This has been smoothed down, but shows the structure of the bone. The barbs are less prominent at one end than the other, but equally sharp. The larger barbs seem near the primary point.

Fig. 233 was found on the island at Brewerton by Mr Waterbury in 1899. It was with a skeleton. The point is obtuse, and the three barbs on each edge are very prominent. The general form is flat and broad, with a ridge on one side. Fig. 231 was found with fig. 234, and is in the Bigelow collection. It is flat, and beveled at the edges. The writer furnished figures of these two and another, to Dr Rau. They are fig. 229, 247 and 248 of *Prehistoric fishing*, and were found in a grave on the Seneca river. Fig. 266 was also found in a grave at Jack Reef, on this river. Several were with it, which were utilized in husking corn. One long and broken one had many barbs on one side.

Fig. 236 is one of many similar examples in the Waterbury collection. They are usually a little ridged, often broken, and with many small and irregular barbs on both sides. Fig. 237 is a rude harpoon found on the site near Pompey Center. The barbs are mere projections, and of unusual form. Fig. 240 is large for a bilateral harpoon, and has three barbs on each edge. It is of horn, and the natural hollow is preserved, the edges of this being neatly worked down. This was found by Dr Hinsdale on the island at Brewerton.

Fig. 241 is of unusual form, and was found by Dr Getman near Chaumont. It is a thick harpoon head of bone, with a single and large barb on each edge. The base is rounded, and the article perfect. Fig. 246 is in the Waterbury collection, and was found by him in 1899. It is nearly flat and very long. Three barbs on each edge are very near one end. Fig. 248 is in the same collection, and is a fine bone harpoon of unusual form and well preserved. The surface is flat and beveled on each side. The slight and sharp barbs are quite far apart, and the point of the harpoon is very keen. Fragments of these are found, but few good specimens.

Fig. 251 was found north of the river at Brewerton by Dr Hinsdale. It is very long and flat, with many sharp barbs crowded near the point. There are six of these on each edge. It expands from the point to the base, which is nearly an inch wide. Across this are shallow cuts, as though it had been intended to make the base square. Fig. 252 was found by the same person and in the same place. It is about the same length as the last, but narrower. The barbs are different, and there are four on each edge. The edges of both are rounded.

Fig. 253 is a fine bone harpoon, of unusual form for an Iroquois site. It is in the Dann collection at Honeoye Falls. There is a single barb on each side, both having a slight indentation half way from the point. From the notch below the barbs there is a gradual expansion to the rounded base. It is of a flattened form. Fig. 255 is a curious little bone harpoon, found by Dr Hinsdale on the Christopher site. There are four rounded or obtuse barbs on one edge, and five sharper ones on the other. It is a little ridged on one surface, polished on both, and with an outline much

curved. Fig. 256 is a small, pointed implement of horn, from Indian Castle in the town of Pompey. Midway on each side are three notches, which may have served for barbs, or for attaching this little implement to a handle. Fig. 257 is a bone harpoon found by Dr Hinsdale at Brewerton. It has the frequent flat surface, angularly beveled down to each edge. The barbs are made by mere sloping notches, and may be unfinished. They are serviceable as they are, but would be improved for use by cutting from the point of each barb to the base of the notch above. The base is broken, but seven barbs remain on each side. Fig. 258 was found by Dr Getman at the mouth of Perch River bay. It is a thick, rounded bone harpoon, with three sharp barbs on one edge. On the other the third barb has been broken, and then recut into two smaller ones. The original barbs on that edge are very sharp.

Fig. 260 is in the Waterbury collection, and is an unusually broad form. The figure shows the concave side of the bone. On this side it was customary to smooth the edges and grind down the point. If the bone was flat, much of the natural surface would be left on the other side. This has three sharp barbs on each edge, placed well apart.

Fig. 262 is in the Richmond collection, and is one of the prettiest bone harpoons yet found in New York. It came from an early site on Farley's point, Cayuga lake, and is polished all over and brought to a point at each end. It is very slender, and has six barbs on each edge. It is also slightly ridged. Fig. 264 is another bone harpoon with crowded barbs, from the Waterbury collection. It is moderately flat, but follows the curve of the bone. There are seven barbs remaining on one edge, and nine on the other. Fragments of about this size are frequent. Fig. 265 is in the same collection, and is well worked. It seems to have been a harpoon cut down to make an awl, but may also be supposed to be a harpoon in process of formation. The former is most probable. Fig. 277 is a bone harpoon found by Dr Hinsdale. The base is broken, but three peculiar barbs remain on each side. The point is rounded and the work good.

Fig. 270 is a fine bone harpoon in the Bigelow collection, which came from the Christopher site. There is a large barb on each side,

and the base is rounded. The shaft is much narrower than the barbs. Fig. 308 is a bone harpoon found by Dr Amidon in Jefferson county. It is a rather flat and long piece of bone, worked on the under surface below all the barbs, of which there are four on each edge, small but very sharp. On one edge a barb was commenced and broken off. To correspond with this none was attempted on the other edge opposite.

In the Waterbury collection is a large and flat bilateral harpoon which has been broken. Some sharp notches make the barbs. All the harpoons and most of the bone and horn articles in this collection are from Brewerton. Dr Hinsdale found there a horn harpoon, much dilated in the center, and with two barbs on each edge. It was 4⅝ inches long, with a central width of ¾ of an inch. His best harpoons were from Brewerton, but he obtained many broken ones from Onondaga lake. The conditions there were not favorable for fine specimens.

Fig. 320 is a perfect and ridged harpoon, found by Oren Pomeroy in the pit at the St Lawrence site. It is worked also on the flat side, and there are three barbs on each edge. In the Woodworth collection are many of the harpoons of Jefferson county, with barbs on one or both sides. A bilateral one ends in a sharp awl at the base, which is an unusual feature. Some are indented, and are not strictly barbed. Dr Rau's fig. 241 is a harpoon from Ontario county, N. Y., presented to the national museum by Col. E. Jewett, which is about 4¼ inches long. He describes it as "a dart head with three small barbs on each side, so placed that they alternate. The upper side is rounded; on the lower one the cavity of the bone reaches from the broken lower end to the lowest barb." It is a characteristic New York harpoon, few of which he had seen, and he adds in his usual cautious way: "I would not venture to say more concerning the use of this dart head, than that it was probably employed in the fish hunt." *Rau*, p. 150

Dr T. B. Stewart sent the writer a good figure of the only harpoon of which he knew in the Susquehanna valley in Pennsylvania, nor have any been reported from that drainage in New York. It was 4 inches long, with sloping linear incisions, as though unfinished, and was found in 1898. He wrote that it "is in section triangular,

and barbed on two edges; the other side is smooth. It is well preserved." It is not very wide, and the edges are nearly parallel.

Fig. 269 is in the Bigelow collection and from the Christopher site. Its unusual character led to special care in verifying it, and the finder was willing to make an affidavit regarding all circumstances. The barbs, if they may be so called, are of unusual form, though such have been found in less pronounced examples. They are pointed protuberances, having nothing of the usual slant, and yet intended to retain the hold obtained. This kind of barb is found at Brewerton. There is a perforation near the base, of an elliptic form. This is a frequent feature at this site and those of corresponding age, in unilateral harpoons and other articles, but not belonging to American bilateral harpoons. The material is horn and therefore antique. There is no appearance of alteration after it was made. This is frequent where early articles of value have been broken, leading to repairs and farther use by the aborigines. This has the original character, and the work does not differ from that of accompanying articles. The evidences of its age have been duly weighed and are decidedly in its favor. The surface shown is smooth and follows the natural line of the material. The other surface is concave and has been a good deal worked. Fig. 352 is in the same collection, and from the same place. It is a thick unilateral harpoon with a single barb, and is much weathered. Fig. 355 is in the Waterbury collection, and has the barbs but slightly developed. Others of this variety are found at Brewerton, where broken implements often have odd features. Fig. 350 is from the Christopher site and in the Bigelow collection. The general outline suggests a flat and rather thin harpoon, with two obtuse barbs on one side and two on the other. It is sharpened to a broad edge at the point.

Fishhooks

In 1884 Dr Rau published accounts of a series of 11 hooks of bone found east of the Rocky mountains, ending with a figure of the only distinctly barbed hook of this material then known. It was furnished by the writer and was then supposed to be of horn, but later examination proved it bone. The first of the series was a simple bone hook from Dakota, apparently not old. It had

neither barb nor terminal knob, and is of a type found on historic sites in New York, as well as those but little older. A corroded one from the Madisonville site in Ohio is older in appearance than others from that place, but this is the result of position rather than age, as may be seen from Dr Rau's account of another with a well cut groove at the top. It was found at the same place. He said: "This hook presents a perfectly fresh appearance, being almost white, and is of excellent workmanship and well polished." *Rau*, p. 127. Another from this spot was perforated at the top — a rare feature. Hooks seen by the writer from that place in general can not be distinguished from similar specimens in New York. There is little reason, from the form, to call any of them old. Other things suggest age. Three out of the 11 hooks were from New York, and other types have been added since.

Dr Rau did not class Schoolcraft's bone fishhook as a barbed hook, though it certainly suggests this. The latter writer said that it was found within an earthwork on Cunningham's island in Lake Erie, and added: "Within these inclosures have been found stone axes, pipes, perforators, bone fishhooks, fragments of pottery, arrow-heads, net sinkers, and fragments of human bones." *Schoolcraft*, 2: 87

Soon after furnishing this figure to Dr Rau, the writer himself found a sharp and well preserved barb broken from a hook. Then the figure of another was sent to him from Jefferson county; then he met with a large one at Toronto, and since then several of the barbed hooks have been found, mostly in the Onondaga territory. While they suggest a knowledge of the white man's arts in their barbs, it is a curious fact that all which can be dated are older than the period of colonization, though well within that of discovery. Those without barbs are both older and more recent, and of course sometimes contemporaneous with those having barbs.

In making a hook, the method was peculiar. With rude tools there was much danger of breaking, and this was carefully guarded against. A piece of bone was brought nearly down to the required dimensions for one or two hooks, and then ground to the desired thickness. Then work began on the inside by boring and cutting. The superfluous material was thus removed and the inside of the

hook formed. Most of the outside could then be fashioned in the same safe way, the critical point being the cutting away of the last outside support. Thanks are due to C. L. Mills, of Columbus O. for photographs of relics showing this progressive work.

A perfect series can not be given with New York specimens, but some may be shown of a distinct or conjectural nature. Fig. 85 was probably an ornament, but will serve to show how a hook might easily have been formed from it, had not the perforation been carried so far. Fig. 227 may also have been designed for an ornament, but may have been blocked out for a hook. In that case the cutting would have been from the half-circular notch downward till the point and curve were formed, and then upward along the shank. Almost to the last there would then have been a firm piece to hold it by. Dr Hinsdale found this on the island at Brewerton, where perfect hooks of about this size were obtained. Fig. 229 better illustrates the usual process, and has nearly the same outline as the last. It is in the Buffalo collection. A hole has been drilled toward the base, and from this grooves have been commenced for forming the point and shank. Fig. 230 is in the same collection, and may have been designed for either a large or a small barbless hook. The intended point seems to have been broken off, causing a change of plan.

Fig. 343 is from the recent fort near Pompey Center, and is a puzzling article if it is to be considered one which had been completed and then broken in using. It might have been a shuttle, had such an article then been in use, but this is unique in form and size. It is therefore suggested that the plan was to make two large hooks from one piece, dividing them in the center when sufficiently advanced. Unfortunately for this, it was broken at one end, perhaps in the mad license of the feast of dreams, perhaps in some accidental way. The curve of the hook is plainly seen at that end, while the work at the other is very suggestive. This article is reduced with the others on this plate, and is 7½ inches long. For its length it is quite thin.

Most of the completed bone hooks are arranged on one plate; and for this reason fig. 313 will be mentioned first, being also of uncertain locality though owned near Syracuse. It is much more

massive than any others reported in New York, is without barbs, and has a slight groove at the top. It is also less angular than usual, and probably is much more recent than those which follow. The writer now definitely learns that it came from Michigan.

Fig. 209 is one of those published by Dr Rau, being his fig. 189. Like all the others, it is of actual size. Dr C. C. Abbott also gave the same figure in his *Primitive industry*, at an earlier day. It was found by W. Wallace Tooker in a shell heap near Sag Harbor. No others have been discovered on Long Island, and it is the largest bone hook yet obtained in New York. This is grooved near the top, forming a neat head, and the curve is well rounded inside. The basal curves, however, come to a point, greatly increasing the strength of the implement there. In this respect it is unique.

Fig. 210 is in A. G. Richmond's collection, and came from Richmond Mills in Ontario county. There is a recent site there. It is small, very angular, and without barb or knob, though the top is slightly curved. Fig. 213 belongs to Dr A. L. Benedict of Buffalo, and was found east of that city. It is thick, but quite small, and has neither barb nor knob. Fig. 226 is in the same collection, and was found at the same place. It is small, thick and very angular, and has a prominent head.

Fig. 217 is from Dr Rau's fig. 186, representing a barbless hook found by F. H. Cushing in the Shelby fort, in Orleans county. Dr Rau says:

> It is made of deer bone, and beautifully polished, especially at the point. The shank expands a little at the upper end, where there are some slight grooves. Viewed horizontally from the lower end, this hook shows in a slight degree the cavity of the bone. It was discovered in an accumulation of debris, 18 inches below the surface, near the center of an old circular earthwork. . . With it, Mr Cushing informs me, occurred various other remains, such as broken bones of animals, rudely ornamented potsherds, flint implements, awls, spatulae, portions of weapons and ornaments of bone and deer horn, shell and stone beads, etc. *Rau*, p. 125

This is the fort which some have argued is 7000 years old. The mention of spatulas suggests those of Jefferson county.

Fig. 218 is in the Buffalo collection and from a site on Buffum street. It is quite small, and the shank is nearly double the thickness of the rest of the hook. It is of the simplest possible pattern.

Fig. 220 is in the same collection and from the same place. It is large for this form, and slightly expands toward the top. Toward the point it is quite thick.

Fig. 219 is from the Atwell fort, and therefore not far from 300 years old. It is in the Burr collection at Cazenovia, and is both small and simple. Its importance is in giving a date to these simple forms. Fig. 223 is in the state museum, and is from Genesee county. It is small, angular and slender, and has no barb or knob. A broken one was with this. Fig. 228 is from West Bloomfield and in the Hildburgh collection. It is quite slender for its size. Two more are in the same cabinet and from the same place, one being broken. These are also quite recent.

Fig. 224 is a broken hook found by Dr Hinsdale at Brewerton. It has a projection at the top, but its great interest is in showing part of the initial perforation near the curve. This proves it to have been broken in making, which is hardly a matter of surprise when the crosscuts at the base are observed. The writer found one of about the same size and as much broken, on the fort site west of Baldwinsville. It can not be determined whether either of these had barbs, but there are good reasons for thinking they did. Fig. 225 is a large, sharp barb from a fort opposite the last mentioned, and south of Seneca river. It indicates a hook of very large size and fine form. The writer sent this to Dr Rau after his work was published, and he adopted the same view regarding its character. The site was probably occupied after the middle of the 16th century.

Fig. 214 is the first barbed bone hook reported in New York, and is a fine and perfect specimen, long in the Ledyard collection and now in the state museum. It is wider than any fish hook yet found, and came from the Atwell fort. The writer was so surprised at its character, when he first saw it, that he took special pains to verify the find. Dr Rau's figure is from his first drawing, made at Mr Ledyard's house; this one was made not long since, when it was for some weeks in his hands. It is of bone, and not of horn, as first supposed. This site is usually dated at about A. D. 1600, and other things there show the influence of white men's implements, though there are no examples of their work or materials.

Dr Rau said of this fine article:

The figure, representing a deer horn fishhook, is copied from a drawing kindly sent by the Rev. W. M. Beauchamp of Baldwinsville, Onondaga co. N. Y. This specimen was found, in 1880, by a laborer on what is called the Atwell site, in Pompey township, Onondaga (or Madison) co. N. Y., and is in possession of Mr L. W. Ledyard, of Cazenovia, in Madison county of that state. The hook being provided with a barb, Mr Beauchamp thinks that it was made, in imitation of the European fishhook, by an Onondaga Indian in the 17th century. There was an earthwork and ditch on the site, which has yielded deer horn forks or combs, bone punches, awls of deer horn, clay pipes, some of them exhibiting curiously intertwined human faces, pottery with human faces at the angles of the rims, and many other objects. The specimen here figured is the only regularly barbed fishhook of aboriginal manufacture known to me, and Mr Beauchamp's view as to its recent origin appears very plausible. *Rau*, p. 128

This fort belonged to the Onondagas, and has been ascribed to lot 44, Pompey. It is really just east of this in Madison county, and was apparently occupied at the end of one century and the beginning of another. The general character of this fine article is much like that of the old Kirby hook.

Fig. 211 is a hook which J. S. Twining bought of a boy named Pryor, who found it 3 feet deep in ashes on Dry hill, some miles south of Watertown N. Y. It is a large, fine hook, with a peculiar barb, and a knob at the top of the shank very neatly rounded. The Twining collection is now in the state museum. Brewerton has furnished several fine barbed bone hooks, described in this paragraph. Fig. 212 is the largest of these, and is in the Waterbury collection. It came from a fireplace on the island, and is narrow for its size. The barb is not sharp, and the top of the shank is a little thickened. Fig. 215 was found on the north side of the river by Dr Hinsdale. There were fish bones in the ashes with it. It is nearly flat, and the slight knob at the top has been broken off. Fig. 216 was found with this, and is a little larger. The sloping and small knob at the top remains. In both these the shank tapers to the top, and they probably had the same maker. Fig. 221 is in the Waterbury collection, and was also from the north side of the river. The barb and interior curve were mainly formed by the large perforation, leaving two straight lines to be cut to this. The

shank gradually expands upward, and then quickly contracts into a groove, above which is a small and thin head.

Fig. 222 is a curious and unique hook from the St Lawrence site in Jefferson county, where it was found by Dr Getman in 1899. It is large, and the shank is very much curved, which is a rare feature. Another distinction is made by two deep notches on one edge near the top. This site is of uncertain age, but was in the early Onondaga territory, whence all barbed bone hooks have thus far been reported. It is probable that a period of 50 years will include all these, and possibly much less. The bone hooks of all kinds here described are from Onondaga or Seneca territory, except the one from Long Island, yet it seems proper to credit Mr Cushing's hook and those from Buffalo to the Neutral nation, which occupied that territory at an early day. None have yet been reported from Oneida or Cayuga sites, but Mr Van Epps saw some hooks from an early grave 5 miles northwest of Schenectady.

The Toronto collection has the largest barbed bone hook which the writer has seen. It is 3½ inches high and has a very long barb. The shank gradually contracts toward the top, which has a distinct head. This was found in Lindsay Ont., Can.

Fig. 101 is a bone frequently found on the Atwell site, which suggests a hook. It shows little work, and was probably not used for this purpose.

Most European hooks figured in Keller's *Lake dwellings of Switzerland* are quite unlike those of New York, and those found in California are also of a different type. Early writers take notice of simple forms near the Atlantic coast, which may have been suggested to the natives by the gifts of earlier navigators. Those thus far found in New York may confidently be referred to gifts of this kind. The Madisonville site, in Ohio, has the simpler forms and is of supposed early date, but nothing has been reported thence which distinguishes it from an Iroquois village of the 16th century except the pottery, and even then pottery with handles occurs in New York. The hooks themselves certainly suggest that period, and it may have been an outlying Erie town, though usually considered a mound builders' cemetery.

That these hooks, wherever found, are due to some knowledge of

Europeans, may farther appear from accounts of early and recent Indian fishhooks. Sagard published his accounts of the Hurons in 1636, and described their ways of fishing.

We found in the bellies of several large fishes hooks made of a piece of wood and a bone, so placed as to form a hook, and very neatly bound together with hemp. *Sagard*, 3:588

Mackenzie traveled in northern Canada in the latter part of the 18th century. He said that the Slave and Dogrib Indians "manufacture their hooks from wood, horn or bone." *Mackenzie*, p. 37. The same writer said, in describing the Indians of the Peace river district, "Their hooks are small bones, fixed in pieces of wood split for that purpose, and tied round with fine watape." *Mackenzie*, p. 206. This was a thread made of small spruce roots. The hook itself is that of the early Hurons.

John Ogilby wrote of the New England Indians in 1671: "They then had *English* Hooks and Lines, for before they made them of Hemp, being most curiously wrought, of stronger Materials than ours, and hook'd with Bone-Hooks." *Ogilby*, p. 157. Kalm said of the Indians of New Jersey:

The *Indians* employ hooks made of bone, or bird's claws, instead of fishing-hooks. Some of the oldest *Swedes* here told me, that when they were young, a great number of Indians had been in that part of the country, which was then called *New Sweden*, and had caught fishes in the river *Delaware* with their hooks. *Kalm*, 1:345

This was in 1749. The assertions or inferences are that the native bone fishhook did not resemble that of Europeans.

Needles

The bone needles of Europe differ from those of the eastern United States and Canada, being usually perforated at one end, and quite sharp at the other. A few have a central eye, and some California examples resemble these. Ours are flat and thin, often rounded at the ends, and have one or two holes near the center. They could have been used only in some coarse work, and might well be called bodkins. It is probable that for finer stitching the bone awl was used, as a shoemaker uses an awl in leather, and that the hemp or sinew thread was carried through the hole as his is now. His is the survival of an early art.

In accordance with general usage, this slender and fragile implement will receive its common name here, bearing in mind the fact that all our own needles are not alike. We have those for knitting, netting and sewing, and even a needle which is true to the pole. Originally and practically the name meant something slender and pointed. The Onondagas now term the common needle *kine-wah a-ne-hong-wah*, nail or iron that you sew with.

Of needles and their uses Mr Morgan said:

A small bone near the ankle joint of the deer, has furnished the moccasin needle from time immemorial; and the sinews of the animal the thread. These bone needles are found in the mounds of the west, and beside the skeletons of the Iroquois, where they were deposited with religious care. This isolated fact would seem to indicate an affinity, in one article at least, between the Iroquois and the mound builders, whose name, and era of occupation and destiny are entirely lost. *Morgan*, p. 360

The mere use of bone needles would here prove nothing, for that is world-wide. It must be shown that others used the peculiar Iroquois form, which thus far seems doubtful.

Mr Morgan mentioned other needles. In making the Iroquois burden strap, he said, "the braiding or knitting of the bark threads is effected with a single needle of hickory." *Morgan*, p. 365. The stitching of canoes with bark twine or tough splints was of a ruder nature.

Mr Tooker has not found bone needles plentiful on Long Island, yet he had some from a *Hogonock* site near Sag Harbor, and says: "In a space 10 feet square, I found five bone needles," accompanied by articles of stone. In his Brooklyn address he used this name. In Rau's *Prehistoric fishing* he called them perforators. They occur on the site of Hochelaga, at Montreal, as might have been expected, and in Canada north of Lake Erie and Lake Ontario. They are found on the Madisonville site in Ohio, if the name is applied to the Iroquois type, but how frequent they are elsewhere in that direction is uncertain. Dr Rau figured none in the collections of the national museum. However they may have been used by others, they were still an Iroquois implement far within the historic period. This would argue a use for which the steel needle was not required. The perforations show that the thread used was not of a large size, and Indian women were expert in making fine

thread. For some uses sinews were required, and for coarse work the inner fibers of bark were used, but the writer has seen very fine Indian thread made from wild hemp, and twisted by merely rolling on the thigh.

Mr Van Epps reported a bone needle which he found at the early Cayadutta fort. It was notched at the head, and had grooves on each side between the eye and the head. It may be that this one had two holes and was broken at one, causing the notch. Perfect specimens have usually two points and a central perforation. One long needle in the state museum, is credited to Fort Hill, probably near Leroy.

John B. James reported two fine bone needles from Van Cortlandt park, in *Popular science news* for August 1896, and April 1897. They were 5¼ inches long, a very large size, and one was grooved in the eye, a frequent feature, probably resulting from the wearing of the thread.

Fig. 72 is a needle in the Dann collection at Honeoye Falls, and of the latter part of the 17th century. It is thin and a little curved, and is sharper at the ends than is usual. There are two small perforations quite close together and near the center. These are united and crossed by a narrow groove made by the thread. Fig. 109 varies from the typical form and is in the Waterbury collection. It is much thicker than is usual, has the perforation toward the broadly rounded end, and is broken at the other. As it tapers slightly toward the broken end, it may have been a perforated awl, and this is quite probable. Supposing it to have this character, it may be compared with fig. 7. Fig. 117 is part of a very long and slender needle from the Atwell fort. It has been broken at the perforation, and, if this was central, it would have had a length of nearly 7 inches. Fig. 118 shows one of two thin, flat and highly polished needles found by Dr Hinsdale on the island at Brewerton. Both were broken at the eye, and the remaining point is quite sharp. They were 3 feet deep in the ashes. Fig. 119 is in the Bigelow collection, and is a broken needle from Pompey. This has been broken beyond the eye, and the point is rounded. It is quite thin and a little curved. Fig. 120 has also a round point, and was found by Dr Hinsdale on the Sheldon fort in Pompey. It has been

broken at the eye, and has the usual flattened form. Fig. 123 is a flat and curved needle, found by Dr Amidon on the St Lawrence site. The ends are well rounded, and the perforation is not central. It is a fine and perfect specimen, though not a long one. Fig. 279 may be called either an awl or needle, having some features of each. It is sharp at one end and obtusely pointed at the other, but has a central perforation, slightly grooved across. It is wide for a needle, and is highly polished. This is from Pompey, and in the Bigelow collection. Probably it should be placed with the awls but may have had other uses. Fig. 280 is in the same collection and from the Christopher site. It is a long and slender needle, sharp at one end and with a rounded point at the other. The perforation is longer than usual, and probably enlarged by use. The groove which crosses it shows how constant was the wear. Fig. 281 is shorter and not so slender, but has much of the same character. These needles are usually flat on one side and a little rounded on the other.

Fig. 284 is from the Atwell fort, and may be an unfinished needle, lacking the proper points and perforation. It is thin and flat, and is somewhat curved. The edges are nearly parallel. Fig. 309 has a similar character. The thickness and curve are shown, as well as the flat surface. One end is pointed and the other left unfinished. In its present state, there is no perforation, but there can be no doubt that it was designed for a needle. This is in the Bigelow collection and from the Christopher site.

Fig. 324 is in one way unique, having one side straight and the other curved. The remaining point is also quite sharp. It was broken at the original perforation, which the groove shows was long used. Then a circular hole was drilled more toward the point, thus making a nearly terminal perforation. This had been scarcely used at all. It is in the Waterbury collection, and is half round.

Very few are perfect, as they are thin and narrow at the outset, and the perforations necessarily weaken them. Use increases this weakness, and they commonly gave way there. Broken forms, however, sometimes have special features, and are at least valuable in showing dates and distribution. Fig. 121 has already been mentioned as unique in form whether classed as awl or needle. It is probably

the former, being quite broad. A Mohawk bone needle is $3\frac{1}{4}$ inches long, and is quite wide in the middle, where there is the usual perforation. A round-pointed needle, broken at the eye and still $2\frac{1}{2}$ inches long, comes from the island at Brewerton. Some with two eyes are broken at both. They occur on many sites and in many collections, but are often overlooked from their inconspicuous character.

Fig. 351 is a good example from the Christopher site, in the Bigelow collection. It is of bone, convex on one surface and concave on the other. Having been long in use, the point has been sharpened as occasion required. The other end is not now pointed and may never have been, though this would be unusual. It is cut squarely across, and this seems the original design. That half also does not follow the plane, as in most needles, but curves quickly out of the line.

Spoons

Iroquois spoons were usually made of wood, but a few have appeared that were formed of bone, horn or metal. Every man was expected to have his own, and to carry it to any feast to which he might be invited. Small sizes were provided for children, and larger for old people. They were broad, shallow, and often of quite a large size. The writer has seen an old Indian friend eating with one not less than 6 inches wide. Such a one may have given name to a noted Mohawk chief of 1660, who was called *Adaquatho*, or Big Spoon.

The Eskimo use horn dippers and spoons. Horn spoons were found in a grave in Windsor Ct.; and bone spoons were among early New England articles. Few have been found in New York, but some wooden and metallic ones have been taken from graves.

Fig. 134 is of bone, and was found on a recent site in Cayuga county, in May 1888. The handle is straight, on a plane with the bowl, and the whole article much like those made of wood. The latter, however, have the handle more at an angle, and generally carved in some ornamental design at the top. Fig. 344 is more like the usual forms in its curves, and is made of horn. It is reduced in the figure, and is a little over $7\frac{1}{2}$ inches long. Viewed from the side, it shows a double curve, and the handle has several notches on

the under side, near the top. This was found near Fort Brewerton, and was shown by J. H. Horton at the Onondaga centennial exhibition.

Whistles and phalanges

Phalanges of deer abound on early village sites, often more or less worked. Many of these have a longitudinal and a lateral opening, and are commonly classed as whistles. Some have a single long perforation, and were probably used as ornaments. Others have a lateral perforation at one end, plainly intended for suspension. The writer has hesitated whether to separate these according to their supposed uses or to place them together according to their natural and slightly altered forms. The latter course is the least difficult and will be followed in this case, some reference to this being made on a later page. Most of the phalanges were probably used in a kind of cup and ball game, as they still are by some Indian tribes. The perforations served to connect them when so used. The common name of bone whistle has been retained here.

Fig. 142 is a neat article of this material, without lateral perforation, but with the ends cut in notches and polished. It was found by Dr Hinsdale at Brewerton. Fig. 203 is worked all over, and has a longitudinal perforation, and a lateral hole near the broad end. The form is like fig. 204, which has been already described as a bone pipe. The essential differences are in its being bored from end to end, and in having the lateral hole near the top instead of the bottom. It is from the Christopher site, and is in the Bigelow collection. The notch crossing the base does not show in the figure.

Fig. 205 is from the same place, and in the same collection. It is of the same form, but is smaller, and is very nicely worked. A scallop ornament of dots crosses one end. It is perforated throughout. Fig. 206 is a slightly worked deer phalanx, found by the writer at the Atwell site in 1896. It is perforated for suspension at the small end. Fig. 207 is a large phalanx, deeply notched each way at one end. This is in the Bigelow collection and from the Christopher site. There are abundant examples of these, varying in little things. One from the Garoga fort, in Fulton county, is well worked, and is perforated at the small end. Such forms may

have fringed the dress or anklets, as the hoofs of deer and sheep afterward did.

Fig. 102 is a small, cylindric bone whistle, belonging to Dr A. L. Benedict of Buffalo. The lateral orifice is toward one end, and is quadrilateral. Fig. 107 is a short, cylindric bone whistle, in the Bigelow collection. This is from the Christopher site, and the lateral central aperture is circular. Fig. 126 is from the same place, and was found by Dr Hinsdale. It is an angular, tapering bone whistle, with an angular orifice near the small end, and is not a common form.

Fig. 135 is from Rice's woods, near Stone Arabia, and has much the outline of the last, but is not angular. The lateral orifice is oblique and elliptic, and the whole surface is well worked. Fig. 208 is a hollow and polished bone, neatly cut at each end and triangular in section. It is of a deep brown color, like many articles from the Christopher site, and is in the Bigelow collection.

Fig. 326 is in the same cabinet, and is a very long bone whistle, hollow throughout. Grooves for a perforation have been cut nearly through on the opposite side, and the unfinished base has been partly cut off. The large aperture near one end is rectangular. The natural grooves appear on this and the next. Both are reduced on the plate, and each is 7¾ inches long. These were found at Jack Reef, Seneca river, with other bone implements. Fig. 327 differs little from the last, but the aperture is narrower and there are no cuts on the opposite side. Another was found with these.

Fig. 328 is a little larger cylindric bone tube, ornamented with parallel and cross grooves. It was found on Dry hill, near Watertown, where the barbed fishhook was exhumed. It is nearly 8 inches long, and one end is charred. Mr Twining furnished the figure, and thought the tube was made from a bone of the human arm.

Bone counters for games

Lacrosse and other ball games were purely those of strength and skill, but every article of value was often staked upon their results. Nation played against nation, and village against village, and the excitement was often intense. The passion for betting and gambling is very strong in the Indian character. So there was found among them the game of straws, analogous to our game of cards, but never

mastered by a white man yet. The game of the bones may have been less widespread, as played by the Iroquois, but the game of the dish or bowl everywhere prevailed, essentially the same in every nation, yet with frequent modifications. A good player of this had as wide a reputation as any chess player of modern times.

A full description of these is not necessary now, but a few words on them may not be amiss.

The Jesuits mention the game of straws among the Hurons in the *Relation* of 1636. Charlevoix gives an account of it as he saw it played in 1721:

> These straws are small rushes of the thickness of a stalk of wheat and two fingers in length. They take up a parcel of these in their hand, which generally consists of 201, and always of an unequal number. After they have well stirred them, making a thousand contortions of body and invoking the genii, they divide them, with a kind of awl or sharp bone, into parcels of 10: each takes one at a venture, and he to whom the parcel with 11 in it falls gains a certain number of points according to the agreement: 60 or four score make a party. There are other ways of playing this game, and they would have explained them to me, but I could understand nothing of the matter, except that the number nine gained the whole party. *Charlevoix*, 2:102

In this we find a pleasurable use for the long and sharp points of some bone awls. They were not merely useful, but were employed in their games of chance. We have another account in *New England's prospect*, describing the Indians there:

> They have two sorts of games, one called *Puim*, the other *Hubbub*, not much unlike Cards and Dice, being no other than Lotterie. *Puim* is 50. or 60. small bents of a foote long which they divide to the number of their gamesters, shuffling them first betweene the palmes of their hands; he that hath more than his fellow is so much the forwarder in his game: many other strange whimseyes be in this game; which would be too long to commit to paper. *Wood*, pt 2, ch. 14

The Indians near New York city were also fond of this game, which they called *senneca* in 1679.

Of the two games resembling dice the writer has given a full account in the *Journal of American folk-lore*, vol. 9. The game of peach stones, or the dish, he has played with Indians, and the Onondagas call it *ta-yune-oo-wáh-es*, throwing the bowl to each other,

as they take it in turn. Six peach stones are placed in a bowl, and the game is used at the New Year's feast, clan against clan. The stones are black on one side, white on the other, and five or six are the only winning points. Six make *o-hén-tah*, a field; five make *o-yú-ah*, a bird. This is the great game described in the *Relation* of 1636. Wood describes it as played in New England with bone counters:

Hubbub is five small Bones in a small smooth Tray, the bones bee like a Die, but something flatter, blacke on the one side and white on the other, which they place on the ground, against which violently thumping the platter, the bones mount changing colours with the windy whisking of their hands too and fro: which action in that sport they much use, smiting themselves on the breast, and thighs, crying out, *Hub, Hub, Hub*; they may be heard play at this game a quarter of a mile off. The bones being all blacke or white, make a double game; if three be of a colour and two of another, then they affoard but a single game; four of a colour and one different is nothing. *Wood*, pt 2, ch. 14

In the *Relation* for 1636 we are told that among the Hurons "both sides bet loud and firmly. When the one on the opposite side holds the dish, they scream loudly, '*Achinc, achinc, achinc*,' three, three, or else *Io-io, io-io, io-io*, wishing that he may throw only three white or three black."

A variety of this game is now played by the Iroquois with eight bone counters, or buttons of deer horn. It is probable that both were at first played with plum stones, so rarely are bone counters found on Iroquois sites. Our earliest account is of stones of fruit. In the domestic game eight bone or horn counters are used, but no dish. So the Onondagas call the game *ta-you-nyun-wát-hah*, or finger-shaker, the pieces being thrown from the uplifted hand on a blanket. The Senecas called it *gus-ga-e-sá-ta*. Six white or black count two, called *o-yú-ah*, or the bird; seven of a color count four, called *o-néo-sah*, or pumpkin; all white or all black gain 20, or a field, called *o-hén-tah*.

Fig. 163 is a Seneca gaming bone, which has been a little burned toward the edge. This is modern, and is in the Buffalo academy of science. Fig. 164 is from another set there, and has dots arranged inside the circumference. One side is red. Fig. 166 is also from Buffalo, but is an earlier and irregularly circular form. Fig. 168 is

similar, but larger and thicker. It is from the Atwell fort, and is a quarter of an inch thick. This is the oldest the writer has seen, and, while some small stone disks may have been used, it is more probable that fruit stones were the original Iroquois dice. They were in use when the game was first described. In some other states bone counters may have been exclusively used, and among the western Indians the dice themselves were of various forms. The Senecas called the peach stone game *gus-ká-eh.*

At an early day the Iroquois children had a game requiring pointed bones. A Jesuit remarked the likeness of Canadian Indian games to those of France.

Among others, I have seen the little Parisians cast an arquebuse ball in the air, and catch it with a stick a little hollowed; the little savage Montagnards do the same, using a little bundle of pine branches, which they catch and pitch in the air with a pointed stick. The little Iroquois have the same pastime, throwing a small pierced bone, which they transfix in the air on another little bone. A young Iroquois told me this, seeing the Montagnard children playing. *Relation*, 1634

George Copway gives a brief account of both games among the Ojibways. First is the tossing play used indoors. An oblong knot of cedar boughs is made about 7 inches long, and to this a string 15 inches long is attached. By this the knot is swung. To the other end of the string a sharp stick is tied, which is about 2½ inches long. "This is held in the hand, and, if the player can hit the large stick every time it falls on the sharp one, he wins." *Copway*, p. 48

This is not very clear, and it is immediately followed by an account of a "bone play" indoors, which is no clearer. In this they use "hoof joint bones of the deer. The ends are hollowed out, and from three to 10 are strung together. In playing it they use the same kind of sharp stick, the end of which is thrown into the bones." *Copway*, p. 48, 49

However little we may understand this, we find in it a use for the worked and perforated deer phalanges not apparent before. At the Pan-American exposition good examples of these bones arranged for this game were shown, five or six in a set, much like those commonly called whistles. The broad and pointed awls with

central perforations for strings, may have been used in similar games.

Rattles

In all Iroquois dances and feasts the rattle in some form is indispensable; but none of these instruments will be figured here. Those familiar to the writer among the Onondagas are made of bark, turtle-shells, cows horns, and squashes or gourds. Strength is required, for they are not merely shaken but struck on a bench. Morgan's description of their use is good. Two musicians sit on the peculiar bench used and sing. "The rattles were used to mark time, and as an accompaniment to the songs. In using them they were struck on the seat as often as twice or thrice in a second, the song and the step of the dancers keeping time, notwithstanding the rapidity of the beat." *Morgan*, p. 280

The turtle-shell rattle is the favorite and ancient instrument, and the Senecas call this *gus-da-wa-sa*. Morgan describes and figures this, and his account is quoted:

> To make this rattle they remove the animal from the shell, and, after drying it, they place within it a handful of flint corn, and then sew up the skin, which is left attached to the shell. The neck of the turtle is then stretched over a wooden handle. *Morgan*, p. 280

Mr Morgan gave a good figure of this instrument, which has been often copied. One made from a very large turtle is reserved for special occasions, being used only in the great feather dance and in the medicine dance with the false faces. It is carried by the chief of the false faces, and its use is quite exhausting. Its name includes two Onondaga words, *kah-nya-ten-go-nah*, big mud turtle, and *ka-sta-wén-sa*, rattle. Smaller ones are also used. The writer's is about the usual size of these, being a little over a foot in extreme length, and was taken from the snapping turtle. The main part of the handle enters the end of the shell, and is strengthened by two diverging splints of polished hickory, penetrating the shell midway in the back, while a similar single splint performs the same office below. It is proper to say that the names varied in the several dialects, and there may be some variety of usage. A moderate difference will be here observed between the Onondaga and Seneca words.

The bark rattle is a long, straight piece of bark, having the ends

and edges neatly turned over, and is rarer than the others. The horn rattle is modern, of course, being made of a cow's horn cut off at both ends. These are closed with wood, as in the bases of old powder-horns. The handle passes through both ends, but protrudes from but one. This rattle may be used in any dance.

Though not made of horn or bone the drums and another rattle may be mentioned here. The gourd rattle retains its natural pyriform shape, and is called by the Onondagas *a-e-tót-hah ka-sta-wén-sa*, the first word being the name of the medicine dance in which it is used. Mr Morgan does not give this prefix. No rattles or drums appear in a condolence, which is purely civic in character.

The Indian drum is *ga-no-jó-o* in Seneca, *ka-na-jú-we* in Onondaga, meaning a covered kettle. It is used in the war dance and many others, but never in the snake dance. The big drum is also used in the annual feast of the dead, held in the spring. Its size is that of a large keg, with the diameter of the old-fashioned churn. The smaller ones, of the size of small paint kegs, are used in most dances.

Knee rattles of deers hoofs were used in early days. The writer has seen sheeps hoofs employed as a substitute. A fringe of these was tied round the leg, and added to the noisy effect of the dance. When brass or copper bangles could be procured, these became substitutes or additional ornaments, and are yet found on Indian sites. The writer has seen conical rolls of sheet iron used in place of these. Every jingling or clashing ornament increased the desired noise of the dance. Some of the worked phalanges may have had a similar office.

Miscellaneous

A number of articles not easily classified will be grouped under one head. Some are unique as far as reports go; but others like them may yet appear, and one aim of these papers is to call out unknown material. In articles of horn and bone this is to be hoped for more than in other kinds. When we remember how great has been our advance during the last 10 years in a knowledge of these aboriginal relics in New York, and how much practically unworked ground awaits examination, we can easily believe that we are now only in the skirmish line, preparing for the later advance in full

force. Some now in the field will fall before that advance is made, but they may be assured that every early effort will have some later value.

Fig. 89 suggests a bone harpoon begun, but the slight notches are turned the wrong way. It is flat, and probably had a sharp point which has been broken off. The general form is that of a flat awl, but these slight and uniform notches arouse conjectures. Harpoons are not rare in the preparatory stages. This is from Brewerton, where these implements have been found in the greatest numbers.

Fig. 98 will introduce the reader to some implements of a puzzling nature. The one here represented is of horn, nearly half preserving the cylindric form, the rest of the long handle being cut into oblong facets, so that it becomes somewhat flat near the groove toward the lower end. This groove produces an irregular square, furrowed on one surface with deep longitudinal grooves. Mr Richmond obtained this in Rice's woods, near Stone Arabia, and thought it had been used in marking pottery. Those who have studied aboriginal pottery will see that such implements were not employed, though the suggestion would be otherwise probable. Such an implement would make parallel lines, and these do not strictly appear on native vessels. It might have been used in scraping hair from hides, but its value for this has not been tested. Had this been its use, more of its kind would have been found, but it seems quite rare. Fig. 338 is another of these, which is also of horn. It was found by Dr Hinsdale on the Sheldon fort site in Pompey. In the plate it is reduced, the actual length being 7½ inches, and the greatest thickness ⅝ of an inch. There are six deep grooves at one end, which are much longer than those in the Richmond example, and are not bounded by a cross groove. The sides are cut down so that it makes a rudely handled and abruptly curving tool. The writer thinks its most probable use was in preparing clay for the finer articles of earthenware. Its furrowed surface and peculiar form would fit it for this use. It is to be remembered that both these sites were occupied in recent times, probably about 1630, and are well supplied with European articles.

Two of these articles are in the Toronto collection, and both are of bone. One is 11¾ inches long and quite straight, the grooves

being on a line with the general surface, but on an expanded part of the implement. The other is more than half as long, somewhat curved, and with the grooved surface at an abrupt angle with the rest. Mr Boyle says: "Both are grooved at one end, as if to produce a pattern on something soft — perhaps for drawing lines to ornament articles of clothing." *Boyle*, p. 77

Fig. 110 is an unfinished angular bone article in the Buffalo collection. One perforation is complete, and another begun. They suggest the use of metallic tools. Two longitudinal grooves were also commenced. While this may have been an ornament, some things suggest an unfinished barbless hook.

Fig. 133 is a curious bone article found by Dr Hinsdale at Brewerton, suggestive of an adz. In outline it shows two sides of a rectangle. The ends are neatly worked at the edge, but not sharp enough for cutting. They could have removed charred wood. The general surface is large and flat, and the implement is thin in the shorter part. It probably had a wooden handle attached. It is a rare if not unique article here.

Fig. 160 was found by Dr Hinsdale at the same place. It is of bone, nearly flat, and quadrilateral. The outline is slightly curved, suggesting a hammer or double-bitted axe, but it is of considerable and uniform thickness. There is a central cross groove, and some notches at the edge. It may have been used for a sinker.

Fig. 161 is a bone ball from West Bloomfield, being one of the two in the Hildburgh collection. They are $\frac{3}{4}$ of an inch thick, and rare. Fig. 285 is a paint cup from the Christopher site, which is made from the base of an antler. It is moderately worked, and shows some traces of its former use. Fig. 299 is an example of some small bone bands in the Burr collection and from the Atwell fort. They look as if a groove had been carefully cut around near the top of a bone suitably prepared, and then a narrow ring of bone had been neatly separated. The Buffalo collection has some of these curious articles. The wonder is that they have so well endured a burial of three centuries. No opinion has been expressed regarding their use.

Fig. 322 is from the Richmond collection, and was found at Rice's woods. The site shows its modern character. In the figure

the implement is half its true length. From the tip of the fork to the chisel point is 7¾ inches, and from the same tip to the extreme point is 10¾ inches. It is an adz made from a deer's antler. The short prong is sharpened to a chisel edge, is nicely worked the entire length and is now very straight. One prong has been cut off, and another left for a handle. This is less worked, but it is a fine and rare implement. In the same collection and from the same place is an antler prong 10½ inches long, cut off at the base, where there are several cuts.

Fig. 331 is a long and hollow bone found in a cache at Cayuga. It has been cut down by grinding, and thus laid open in the center. The orifice is 4¾ inches long, and the bone has a length of 11 inches. The joints are left at each end. It was full of red paint when found in 1886, and a small, elliptic sandstone pestle or muller, 3 inches long, lay along the opening. It is much reduced in the figure. Fig. 332 shows a fine bone mortar from the Garoga fort, which is in the Richmond collection. It is reduced in the figure, being 4¾ inches high, 2 inches wide at the top, and 1⅜ inches at the bottom. It is excavated nearly to the base. The accompanying bone pestle has been already shown.

A large number of long bones from Ohio were in the Pan-American exposition, and were called scrapers. They were cut much like fig. 331, but more deeply, and probably had the use assigned. The Cayuga example was a paint box.

Fig. 342 is one of the rarest of all New York articles, being an implement made of a walrus tusk. It is curved, angular, and has been ground to a broad point at one end. The actual dimensions are 16 inches of length, and 1½ inches of thickness, being nearly as wide throughout as at the thickest part. With it were found large bones and other relics, and a gouge of walrus tusk broken in two. Unfortunately this fine article is much weathered. It came from the early fishing place at Brewerton.

Fig. 349 is a novel implement in the Bigelow collection, and from the Christopher site. It is a well worked bone naturally deeply grooved on each side, but with the edges of the grooves ground flat. A rounding crosscut connects these at each end. The one at the basal joint is not conspicuous, but the other is very deep, form-

ing a curved and prominent horn on each side. Both these are ground to a rounded cutting edge, and might have been used for cutting strips of hide with parallel edges. The shorter horn has been split and recut, and both are ground from the inside, the natural curve of the bone remaining without. The edges are very slightly ground outside, and cracks nearly reach the base.

Fig. 353 is another novel article from the same site. It might be called a flat double chisel or gouge, being sharp at both ends. The material seems to be horn, and the edges are ornamented with notches. These edges are parallel, moderately deep in the center, and there are two circular perforations near the center of the implement. One surface is nearly straight, and retains part of a natural longitudinal hollow. The other curves, and has a deep, broad hollow, worked from end to end, as in the figure. This fine article may have been a shuttle, or have been used in some game.

A piece of horn has been cut off from an antler and partially worked. It is 5¼ inches long, and has been excavated on one side, perhaps for a paint box. This is from the Otstungo fort and is in the Richmond collection. The writer found part of an antler on the Wagner hollow site in Montgomery county in 1889. It had been neatly cut off and was partially worked, though most of the original surface remains. Toward the upper end broad diagonal grooves have been cut. It is 4¾ inches long by 1½ inches thick. Copper saws were found on the same site.

A slightly curved bone implement is in the collection of H. A. Pride of Holland Patent. It was found in the town of Marcy, on the north side of the Mohawk river, and not far from Oriskany. The sides and edges are parallel, and it is 5¼ inches long and over an inch wide. The thickness is ⅜ of an inch. Both ends are brought to a moderately sharp edge, suggesting a double chisel, but one of these has the characteristic feature of fig. 98 and 342. Parallel grooves extend from the end on one surface, for over an inch of the length, making a corrugated surface there. They are arranged as in the other examples, and probably had the same use.

In the collection of the Onondaga historical association is a bone spool, given to that society, Mar. 29, 1895, by Mrs Pierce, an Indian

woman. It was made by Harry, son of the noted Ephraim Webster, and is much like the wooden ones in form. Indian thread is wound on it. A folding bone toothpick in the form of a fish accompanied this and was made by the same chief. Some Indians at Onondaga have done fine carving in bone.

A hollow bone, nicely wrought at one end, perhaps for a box, was found at Brewerton. It is 2⅞ inches long by 1 inch broad. A long and curved bone is in the Buffalo collection. It is perforated at one end, and polished. The length is 4½ inches.

In treating of these things many fine articles have been passed over, because representative forms were needed, and even then the illustrations have exceeded in number those used before. Some are not so remarkable for form as for the high polish given centuries ago, and retained in the earth to the present day. The sharpness of some points is wonderful, and yet, aside from their daily use by their makers, these have often been preserved unharmed for over 300 years. In no class has the writer been so inclined to exceed his limits as in that of harpoons. They are so abundant and variable, that almost every fragment has a charm of its own. A large proportion are of course fragmentary, not strictly fine specimens, but each has its own features.

In some cases it has been difficult to distinguish horn from bone without marring the article, but this is a point of slight importance. Both materials were abundant, and it was merely a matter of choice or convenience which was used. Large harpoons were often of horn, and this seems to have been preferred for the hollow points commonly called arrowheads. Awls were usually made of bone.

The presence of certain bones and teeth is not without interest. In the refuse of the towns, jaws, teeth and bones occur, showing traces of the usual food of the people. Something might be gained in this way from a study of the implements, were this at all needed. Some remains of this kind are certainly suggestive. The presence of two walrus tusks at Brewerton may have resulted from aboriginal travel or trade. In one collection in Jefferson county the writer found a buffalo's tooth and the palate of a drumfish. Close inspection might show other strange materials. The local collector should

look well to these. They are not showy things, but are none the less valuable in revealing early life. A bare reference to them will suffice in this paper, which treats of implements and ornaments, and not of food.

To show how little was generally known of bone articles in New York but a few years since, reference may be made to A. E. Douglass's table of Indian relics in his fine cabinet, in 1896. He then had 36 bone implements, 17 of which came from New York. His 30 bone beads included no New York specimens, and but one of his six bone ornaments was found here. Of his 73 images, masks and heads of all materials, but eight were from the United States, and none from New York. The character of the collection is mainly the result of personal opportunities and limitations, and, because of this, some little known collections of a local character are very important in determining geographic distribution and illustrating rare forms. For a similar reason, it seems proper to quote David Boyle's remarks on bone articles in Canada, the home of the Hurons and Neutrals, who were kindred to the Iroquois of New York, and whose remains are directly related to those found here. Mr Boyle says:

Many tools and a few ornaments were made of bone and horn, but no weapons appear to have been produced from these materials, unless we include those known as harpoons having one or more barbs. On account of the extensive use of bone by the Eskimo, there is a strong temptation to refer many of our specimens of this kind to Innuit origin, especially as the resemblance of ours to theirs is often very marked. But, in this respect, there does not appear to be any more reason for so doing than there is for attributing the same origin to flints, vessels of soapstone and some other things. Still, when we take into account the Huron-Iroquois tradition as to the former abiding place of the nation on the north shore of the Gulf of St Lawrence, we may at once concede the probability of strong Eskimo influences affecting the work of our Indians. *Boyle*, p. 72

Mr Boyle seems to refer the early Iroquois to the north shore of the Gulf of St Lawrence, but the Eskimos lived there in historic times. The Iroquois made the unilateral harpoon of bone long after the whites entered New York, and the bilateral to some extent. The age and origin of many of these are clearly proved. Mr Boyle goes on to say of one fine article:

Barbed bone hooks are extremely rare. I have heard of two or three others, but this is the only one I ever saw. It is not too unreasonable to suppose "white" influence to have been here at work at a comparatively recent date. It has been noticed that articles made of bone are much more frequently found in some parts of the country than in others. In the Ottawa and St Lawrence counties few bone specimens occur. In the old Huron country they are comparatively rare, and not many are found in the western counties. On the other hand, large numbers have been collected in the neighborhood of Toronto, of Brantford, and in North Hastings county. Awls are the most common form of bone tool. They are from 2 inches to 8 or 10 inches in length. They are sometimes spoken of as needles, but it is most likely that their use was to perforate bark and skin before inserting the thong or fiber employed for sewing. Another form also known as a needle . . . was almost certainly employed in the netting of snowshoes, and in the making of grass mats, for passing the binding string or thong of sinew or root fiber in and out among the stalks of grass as they hung suspended from a bar in front of the worker. It is, therefore, more like a shuttle, although it was not *shot*. An unfinished Ojibwa mat in the provincial museum, yet attached to the original bar shows how the work was and is performed by the native women. *Boyle*, p. 73

This latter needle is the one known by that name in New York. It may be supposed that deeper excavations on village sites will reveal many articles of bone in the Huron country. European articles were so soon taken there that bone may have soon been disused on historic sites. This was not the case in the Neutral country. Mr Boyle proceeds:

As pins to fasten clothing on the person bone was the best material procurable, and it is not unlikely that many of the so called needles were employed in this way. Specialized forms are found occasionally on which some pains have been taken by way of ornamentation. . . Pins of this kind are generally spoken of as pottery markers, but as a rule the designs on Indian clay vessels required no special tool. Implements for dressing skins very effectively were made from the metacarpal bones of large quadrupeds like the moose, caribou and common deer. Some of these tools are quite smooth at the scraping edge, while others are neatly notched to give them additional grip. *Boyle*, p. 74

These are cut like a gouge or chisel, and the ornamented awls are like those of New York. So are the combs, beads, pendants and grooved implements. Carving of human figures and faces was recent; and Boyle says nothing of bone whistles there. Horn was

less used than bone, and some Canadian articles of this material have not been reported in New York. In his report for 1899 he speaks of a considerable number of phalangeal bones from old village and camp sites, adding that "the most commonly accepted theory is that the bones were in some way used as whistles, but nobody has ever been able to produce a sound from them." Most of his examples were found but a few miles from Toronto, and resemble some New York specimens. Stewart Culin is inclined to think they were used in games, and in this theory the Eskimo comes up again. Skull perforation in Canada was after death. The perforated horn articles which Mr Boyle supposed were used for straightening arrows have not been reported in New York. It may be that the artificially grooved boulders took their place.

EXPLANATION OF PLATES

Page numbers refer to descriptions in bulletin

Plate 1

Plate 2

Plate 14

Plate 15

Plate 16

Plate 17

Plate 22

Plate 23

Plate 24

Plate 42

Plate 43

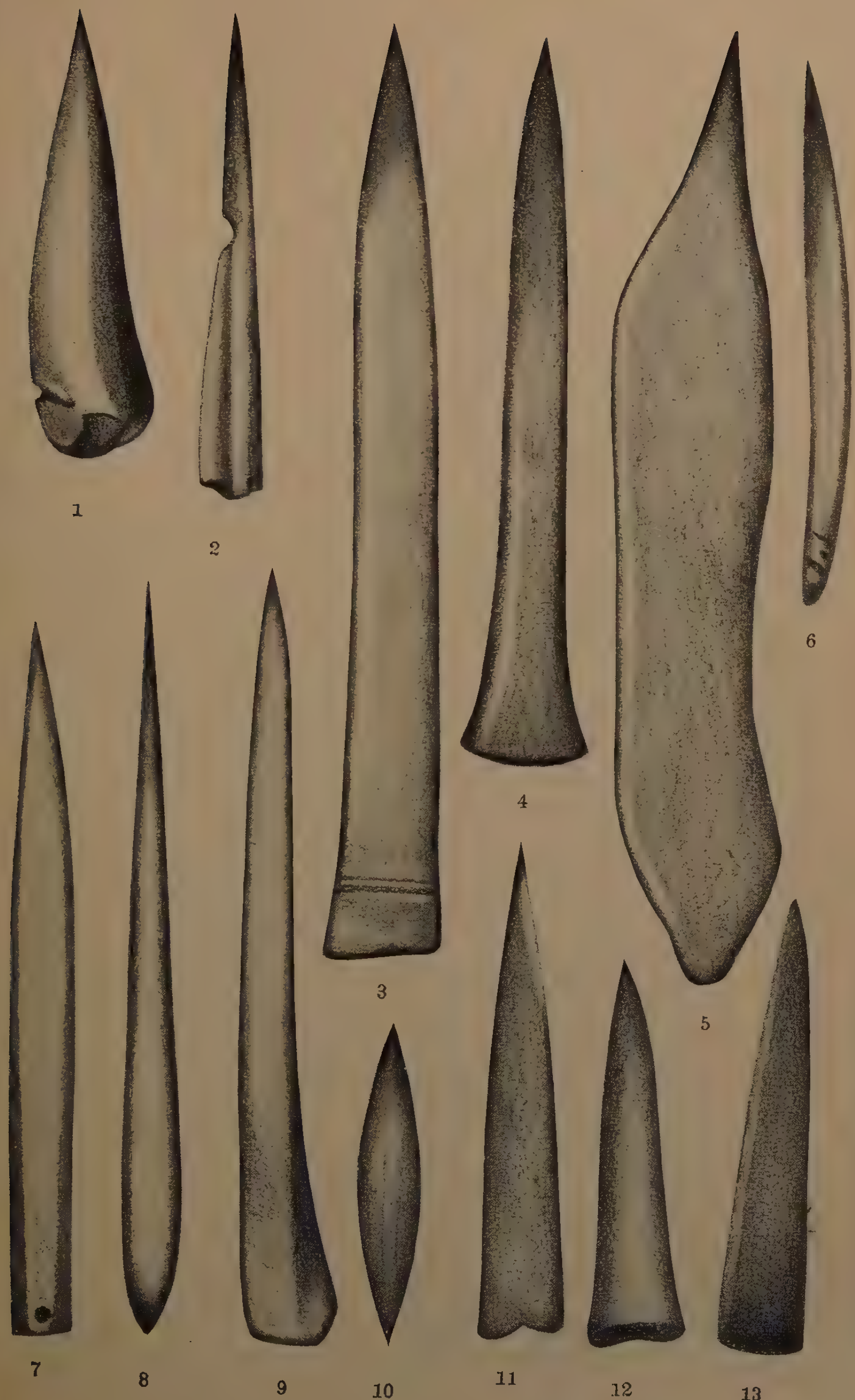
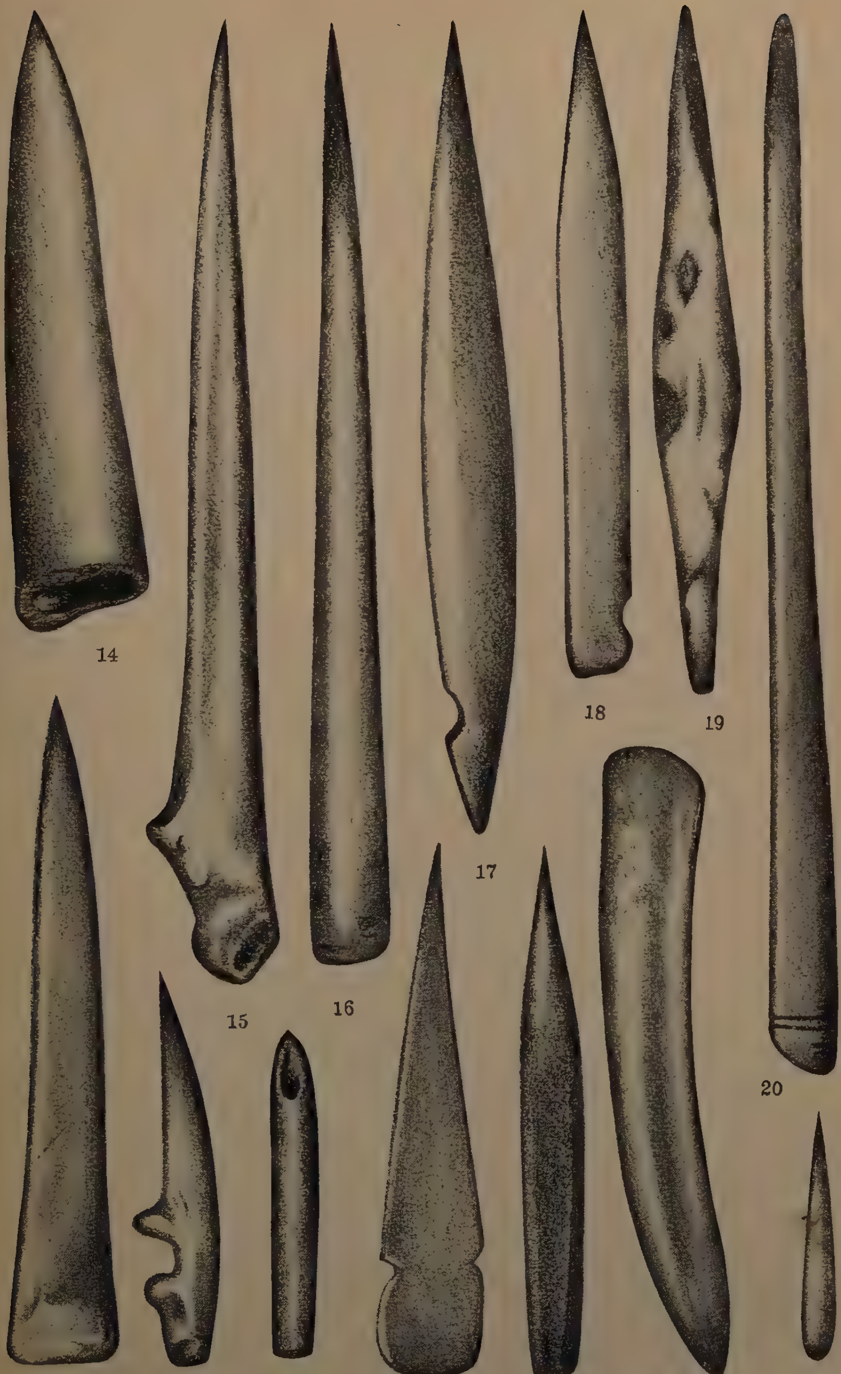

1
2
3
4
5
6
7
8
9
10
11
12
13

Plate 2



14 15 16 17 18 19 20 21 22 23 24 25 26 27

Plate 3

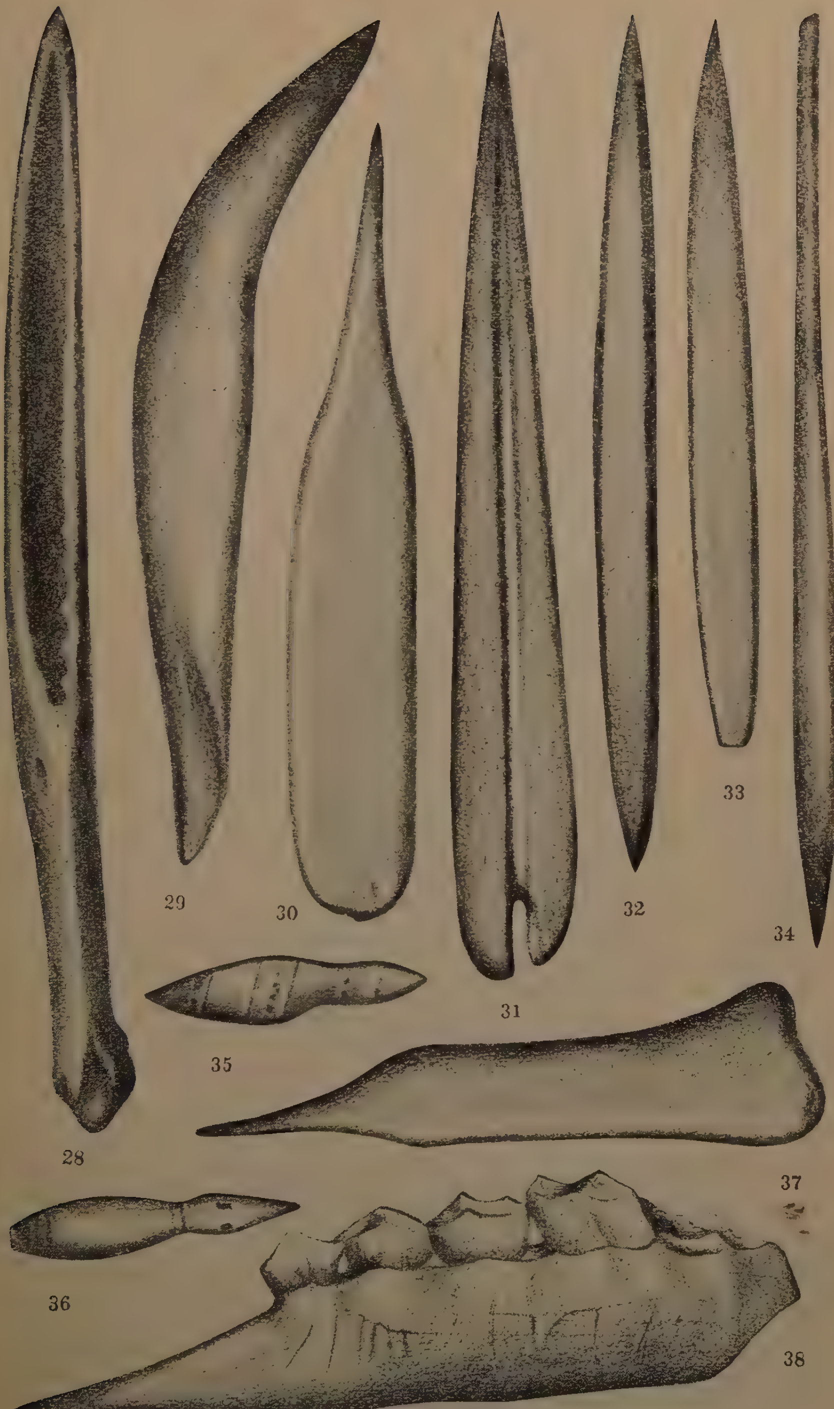
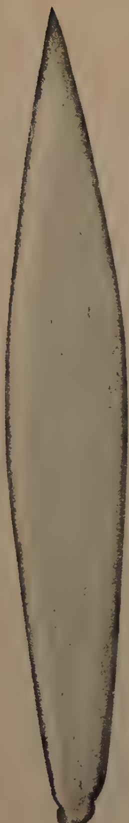


Plate 4

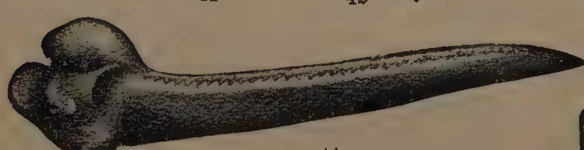

39


40


41


42


43


44

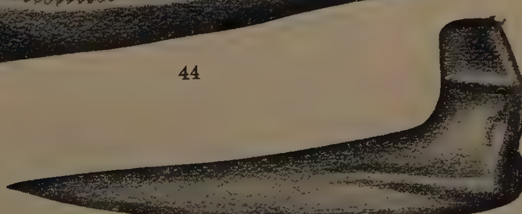

45

Plate 5

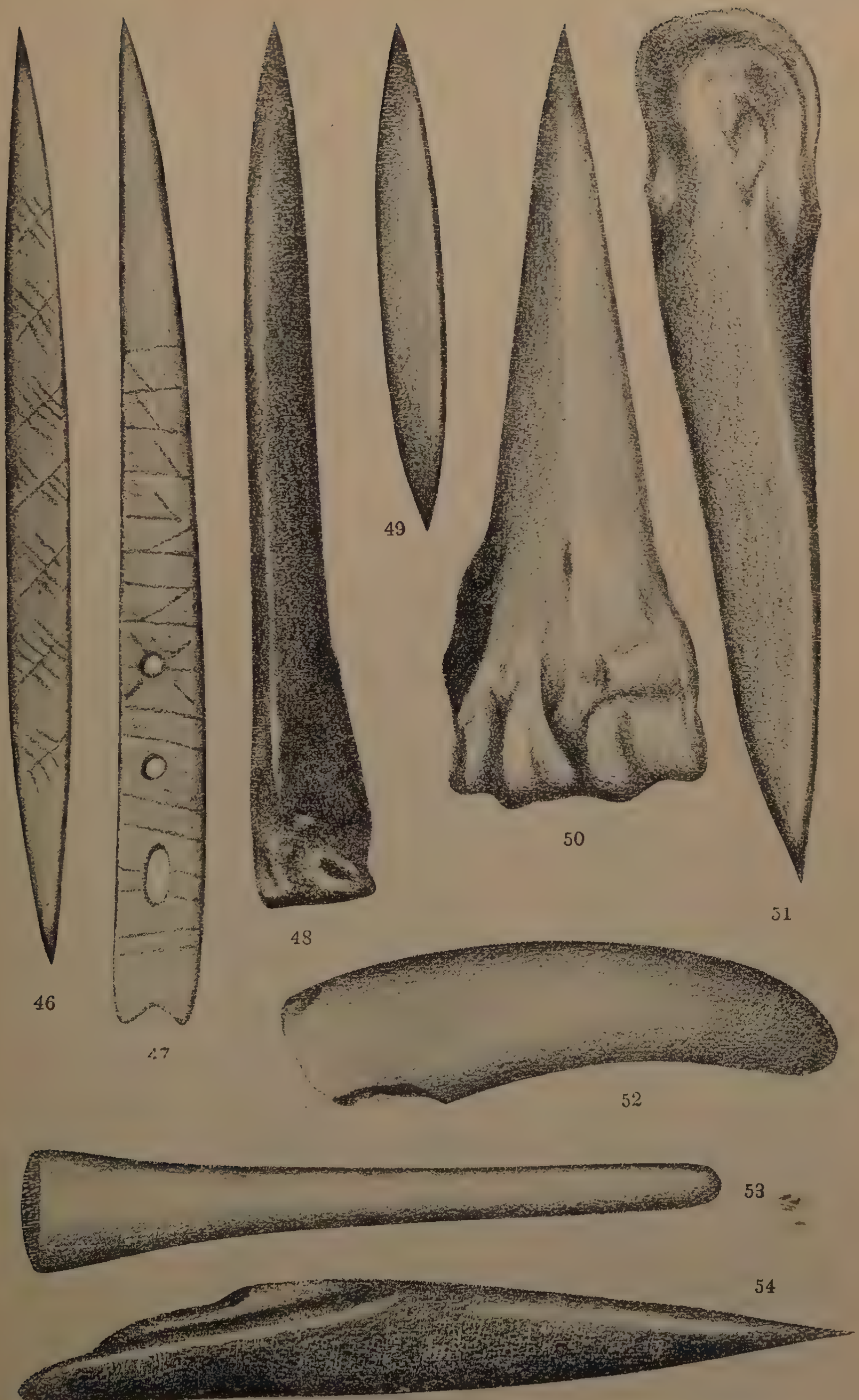


Plate 6

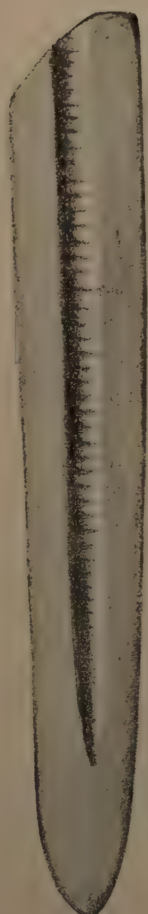
55

56

57

58

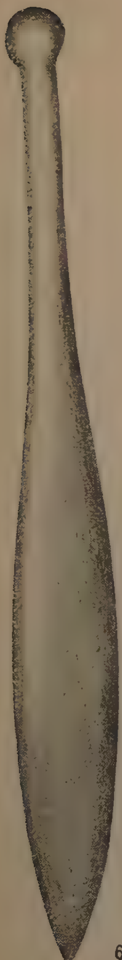
59

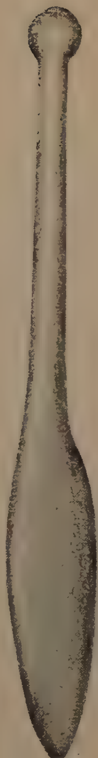


60

61

62


63


64


65

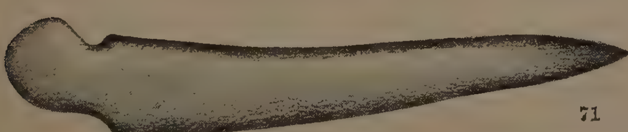

66


67


68


69


70

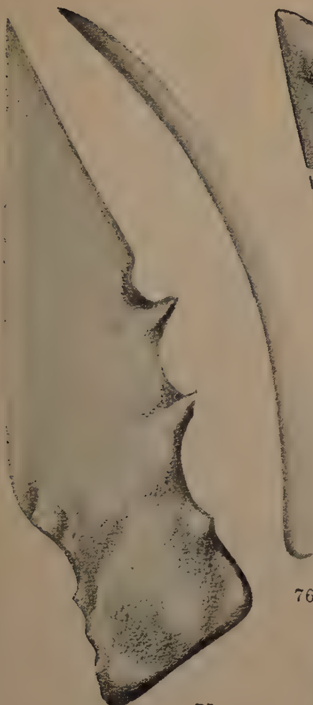

71


72


73


74

Plate 8



75

76

77

78

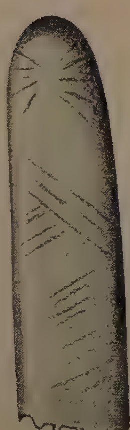
79

80

81

82

83



84

85

86

Plate 9

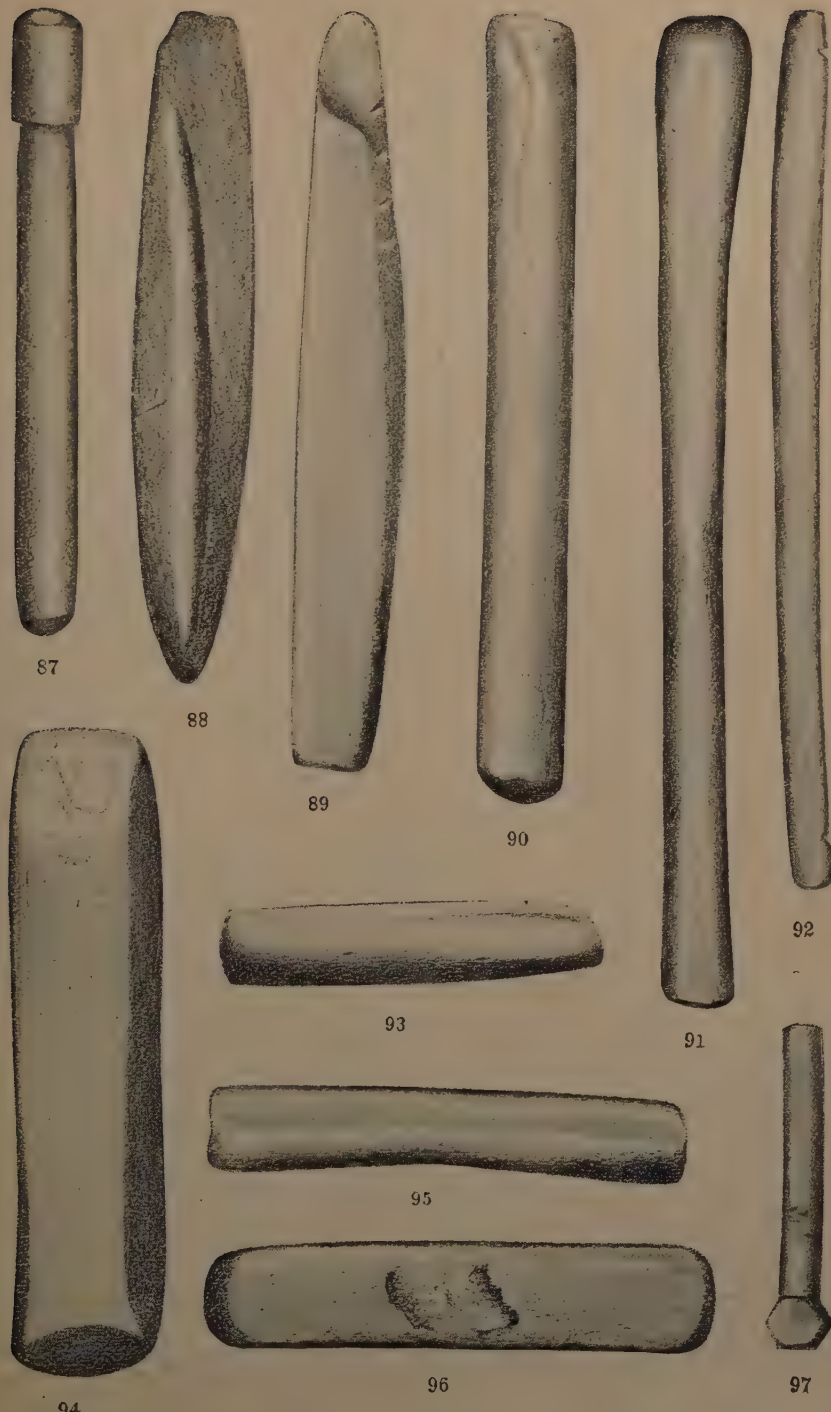


Plate 10

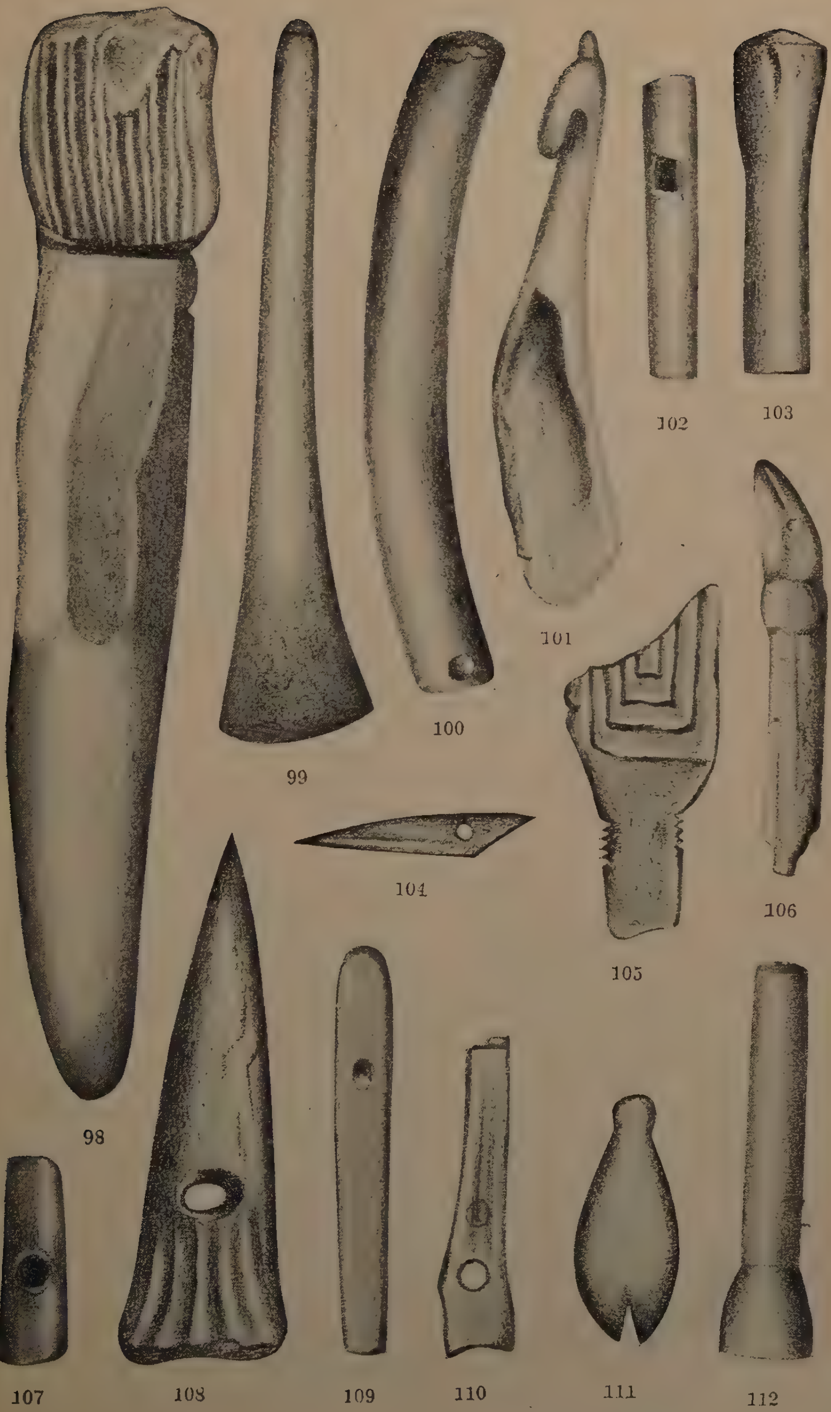
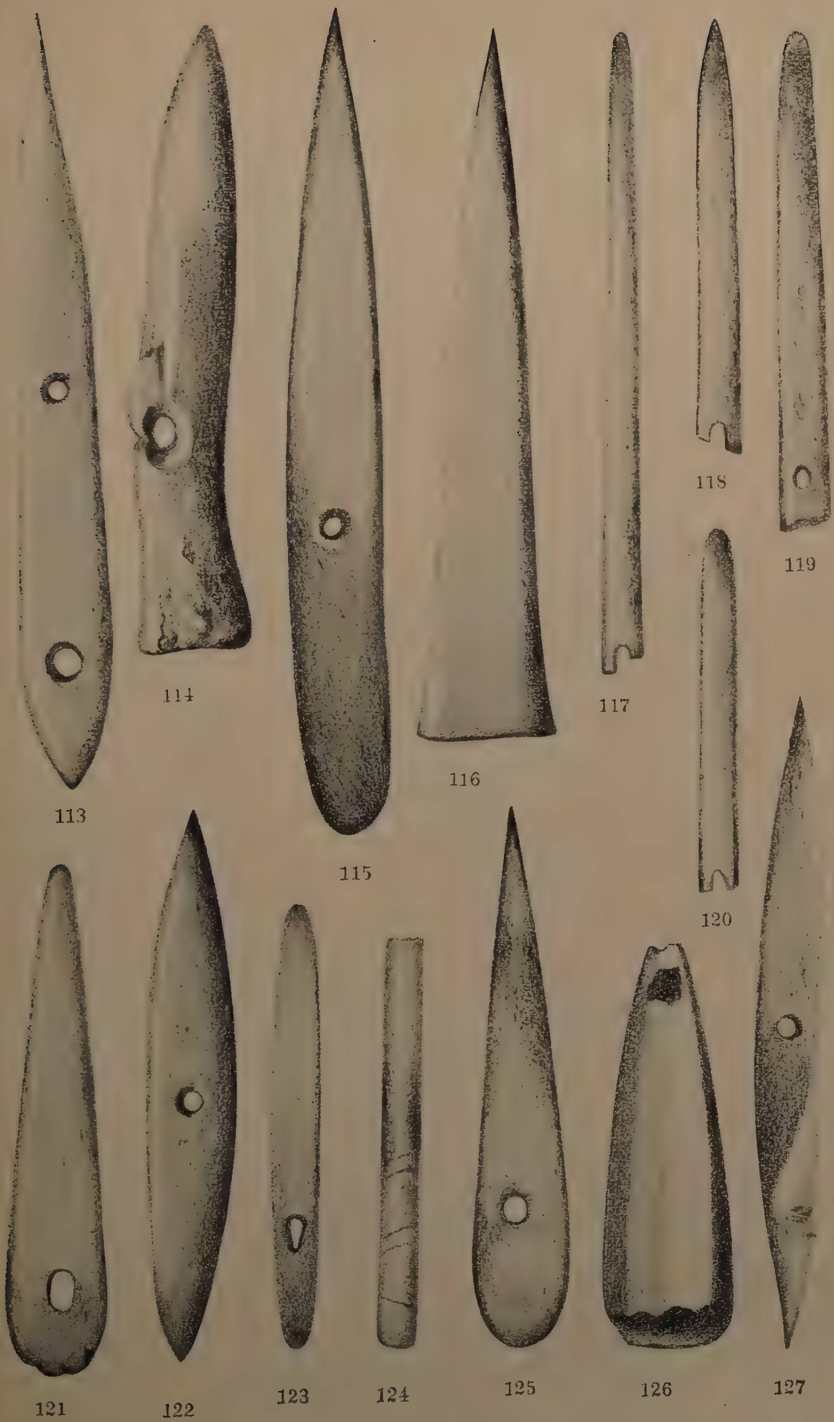
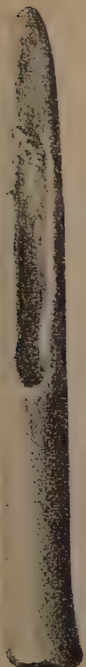


Plate 11

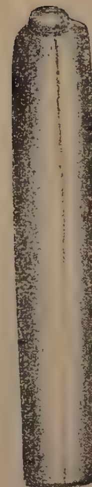




128

129

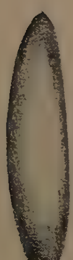
130



131

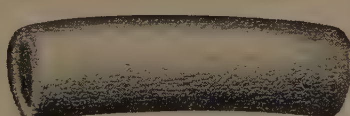
134

133



132

135



136

137

138


139 140 141 142 143 144 145 146 147 148 149

150

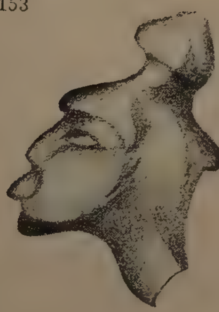
151

154

152

153

155



156

157

Plate 15

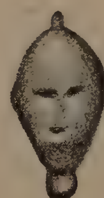
158 159 160 161 162 163 164 165 166 167 168

169

170

171

174



175

176

172

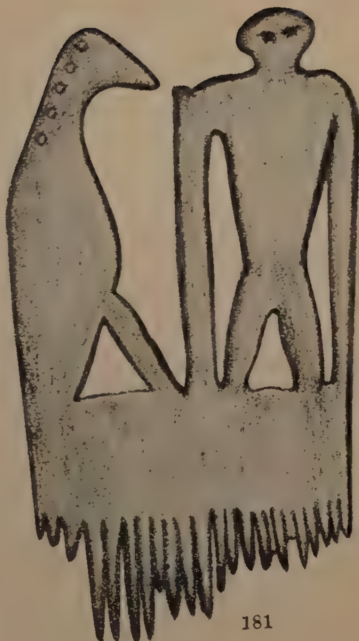
173

177

178

179

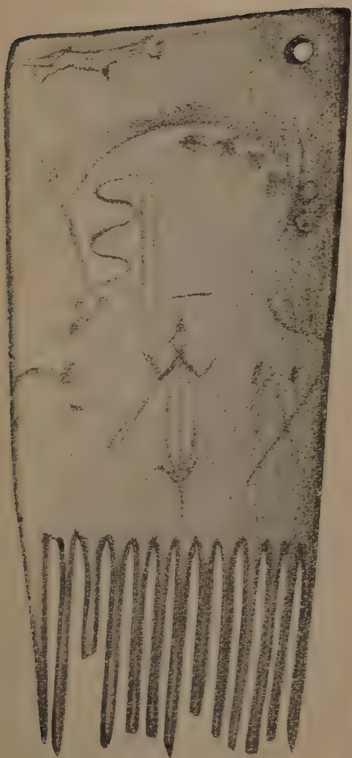
180



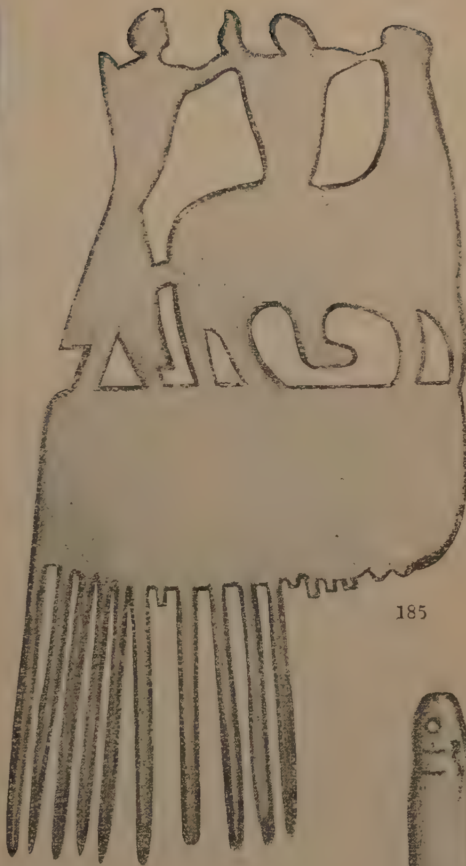
181

182

183

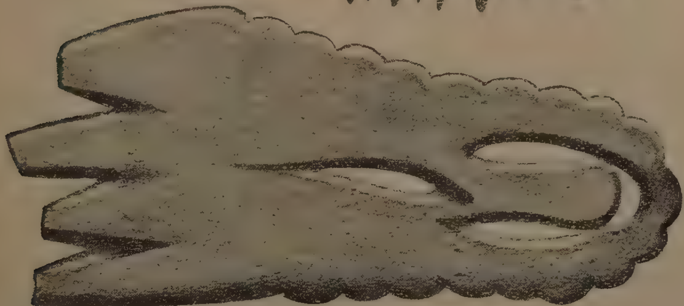


184



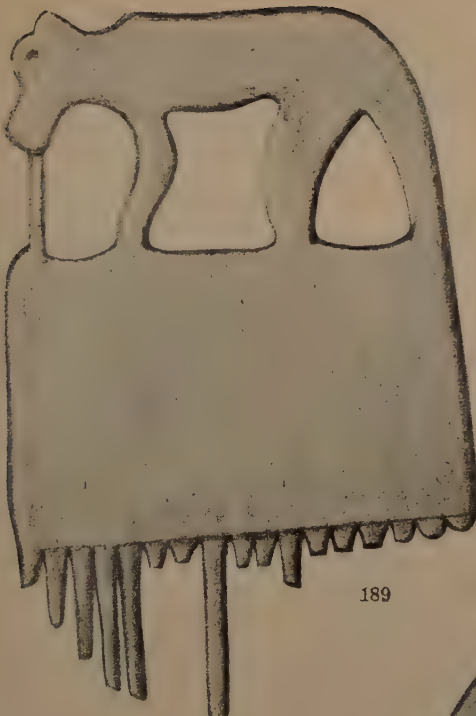
185

188



186

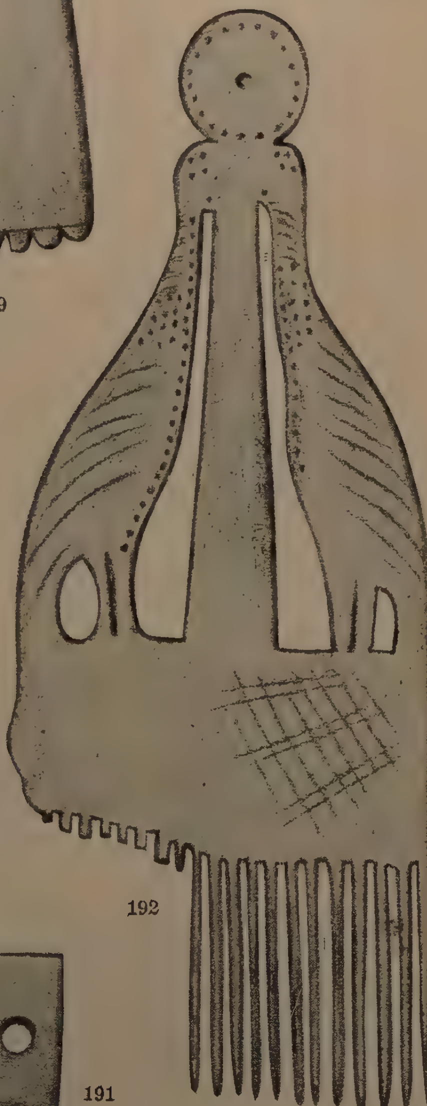
187



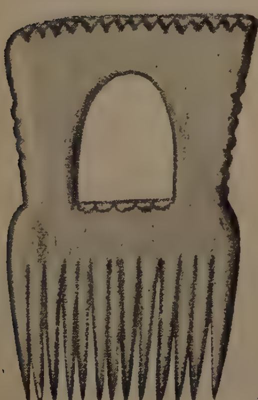
189

193

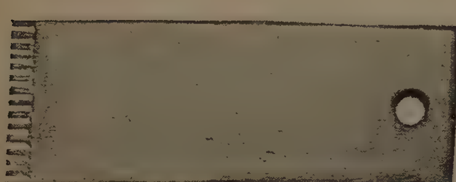
194



192

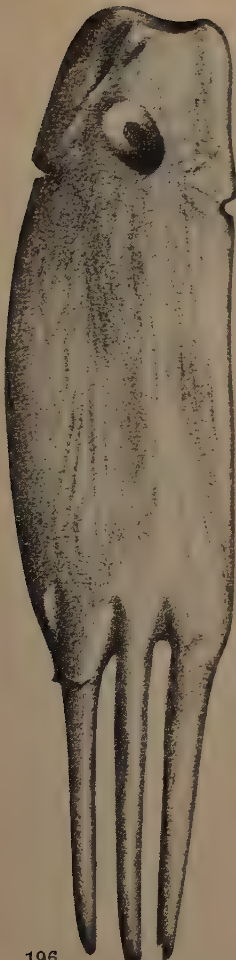


190

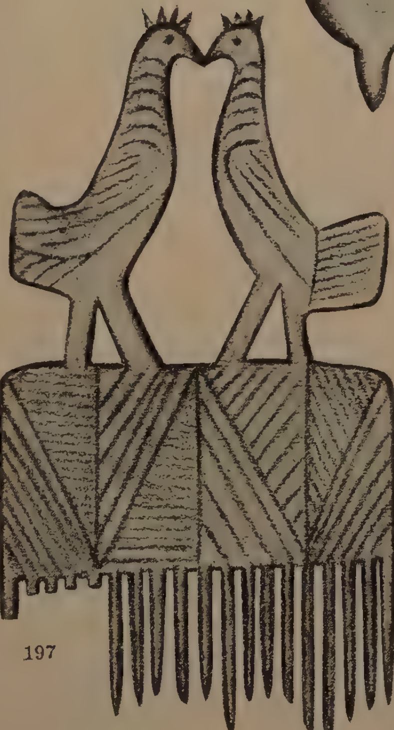


191

195

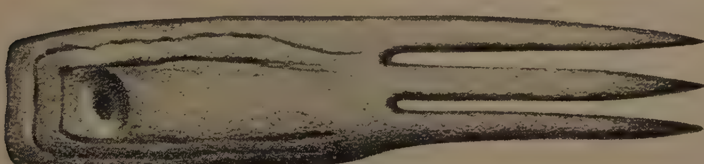


196

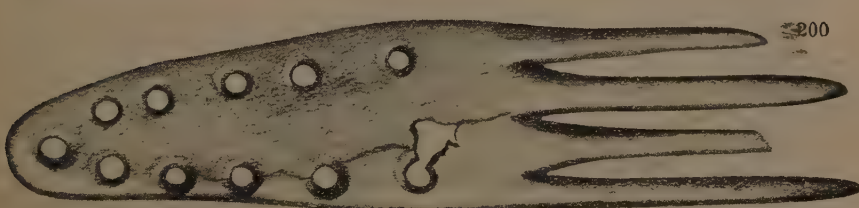


197

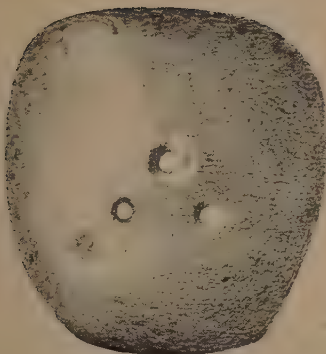
198



199



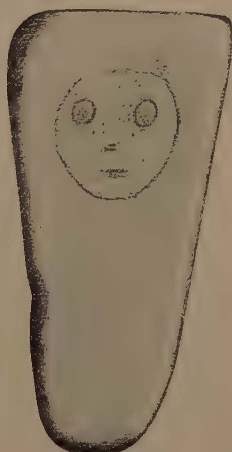
200



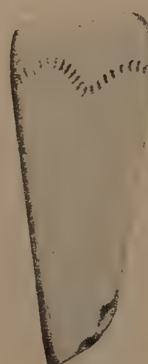
201

202

203



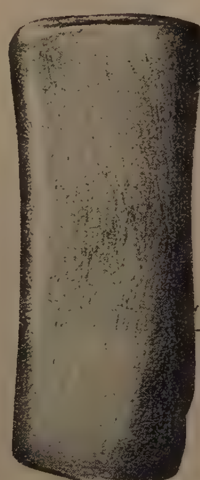
204



205

206

207



208

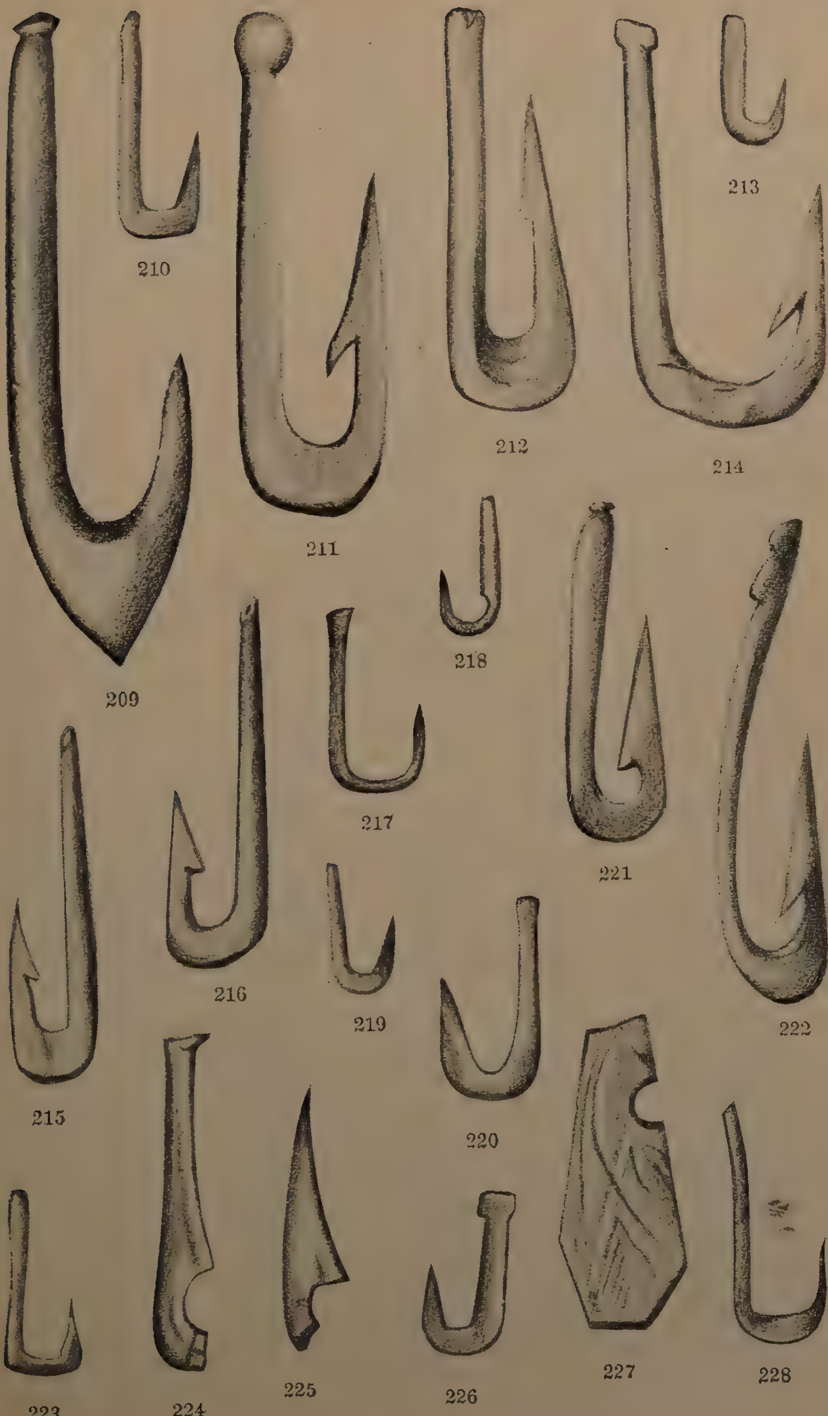
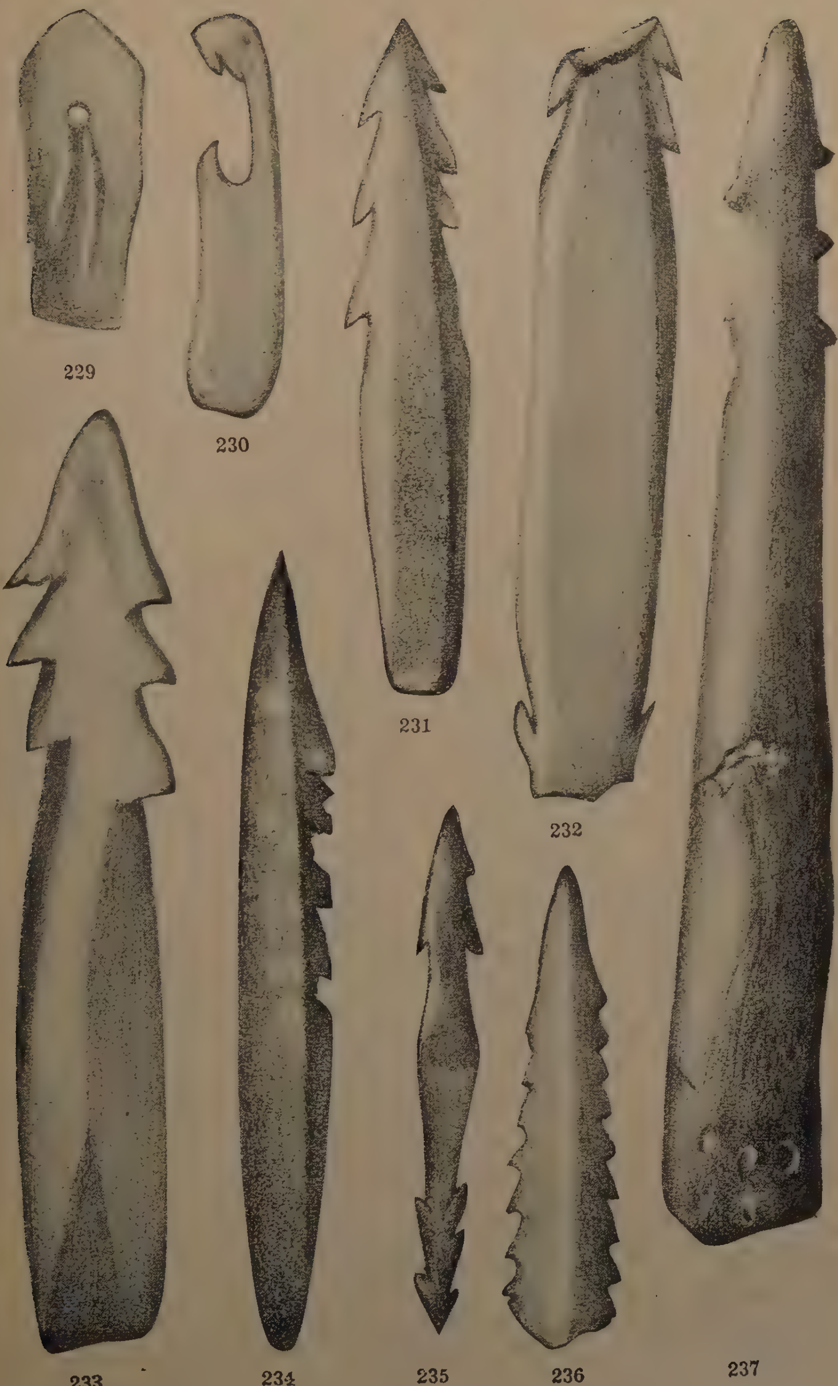
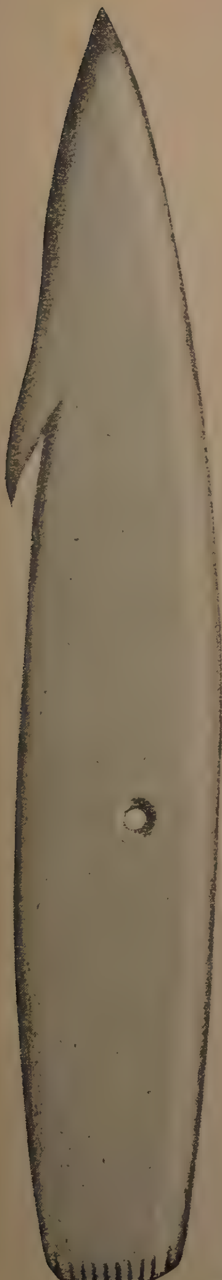

210
211
212
213
214
209
218
221
217
222
216
219
215
220
227
228
223
224
225
226

Plate 23

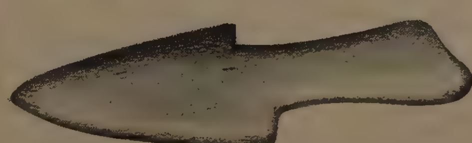




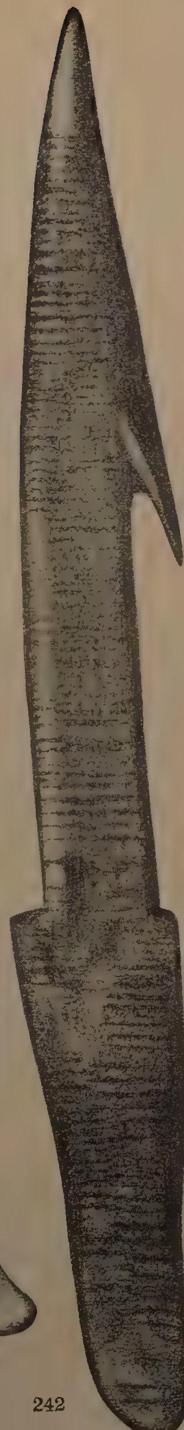
238

239

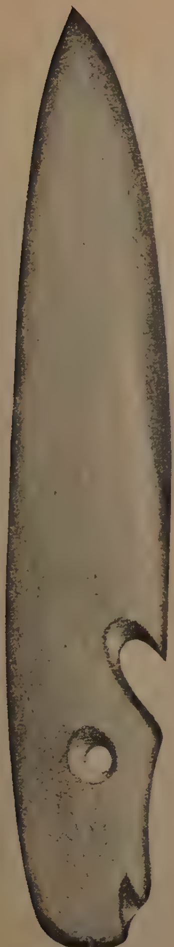
240



241



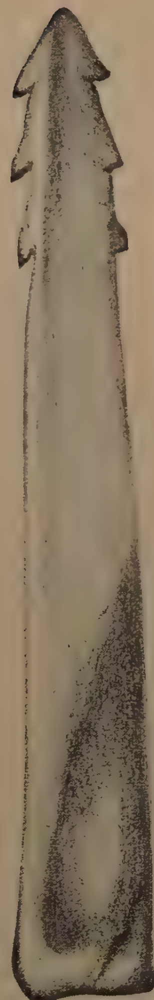
242



243

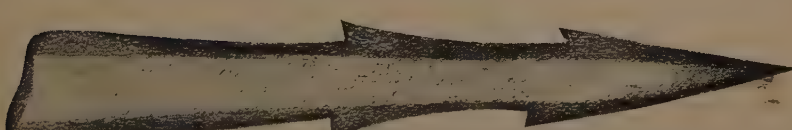
244

245



246

247



248

249

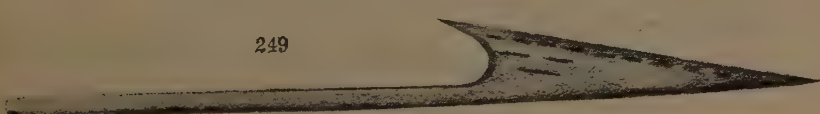
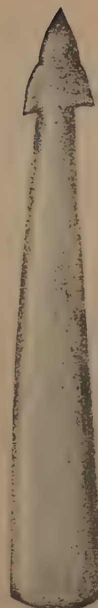


Plate 26


250


251


252


253


254


255


256


257

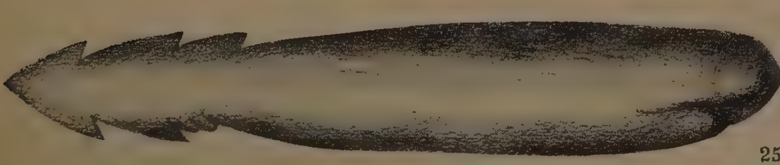

258

Plate 27

259

260

261

262

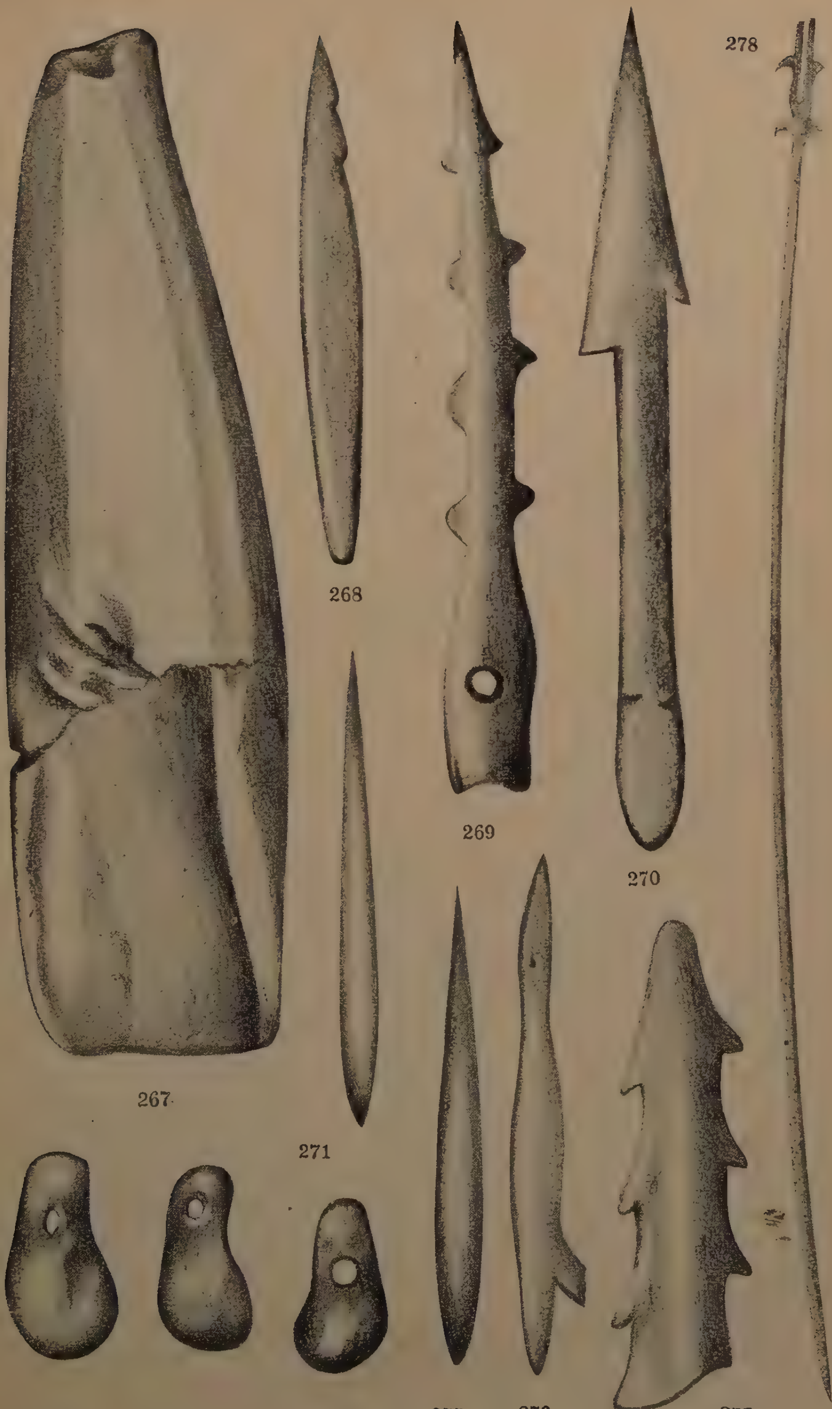
263

264

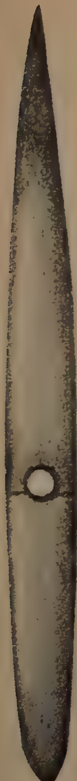
265

266

Plate 28



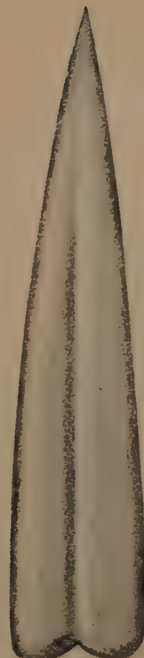
267 268 269 270 271 272 273 274 275 276 277 278



279

280

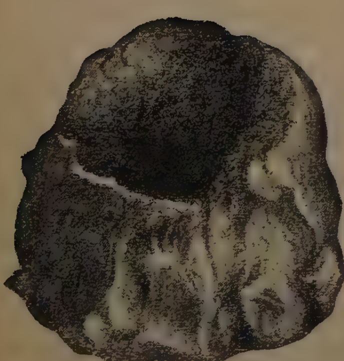
281



282

283

284



285

286

287

288

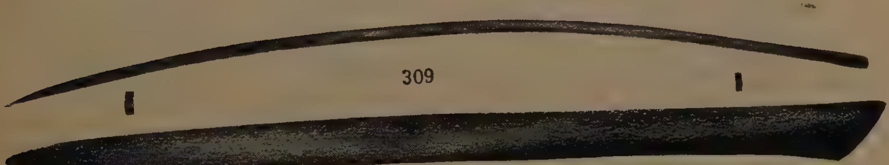

289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304

305

306

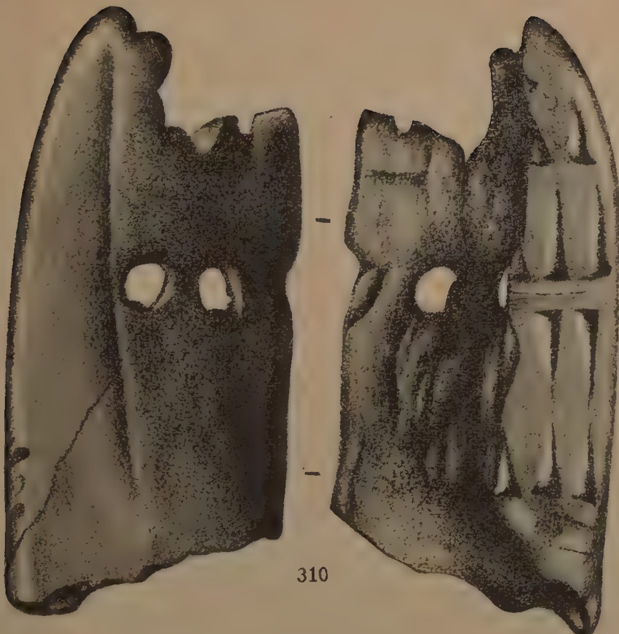
307

308



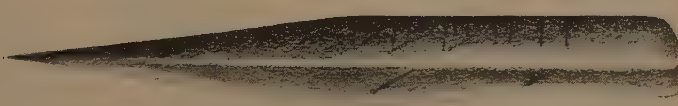
309

Plate 32



310

311

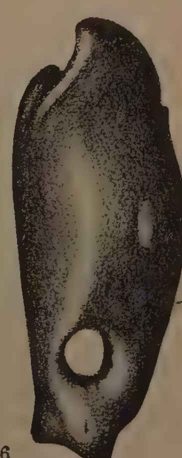


312

313

314

315



316

Plate 33

317

318

319

320

321

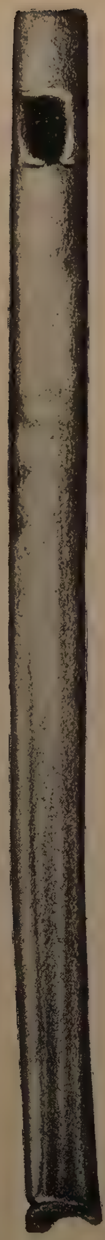
322

323

324

Plate 34

325

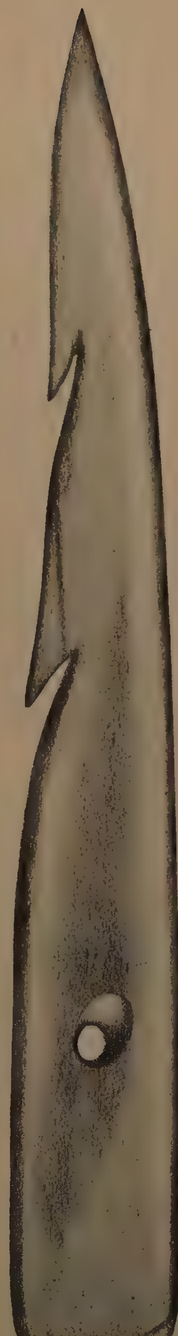


326

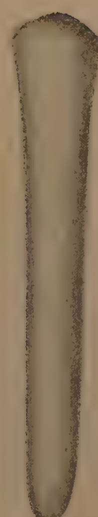
Plate 35

327

328

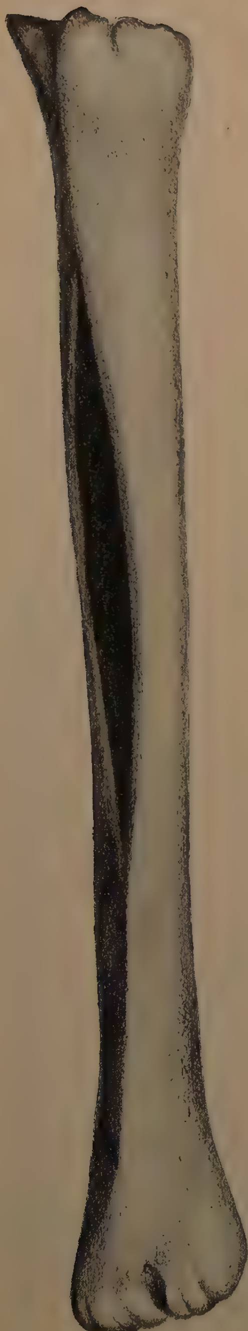


329

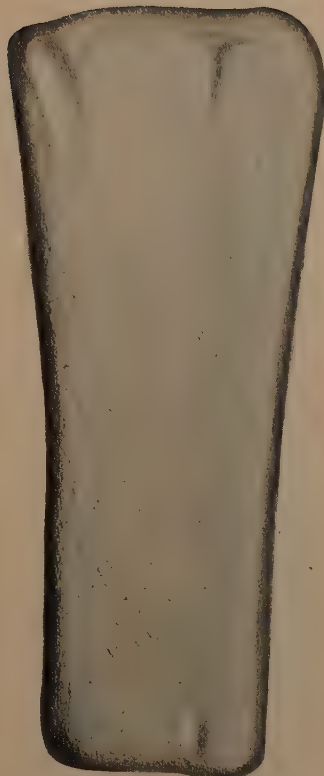


330

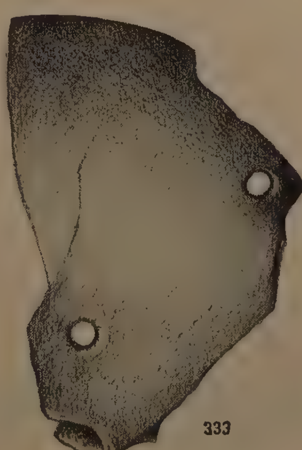
Plate 36



331

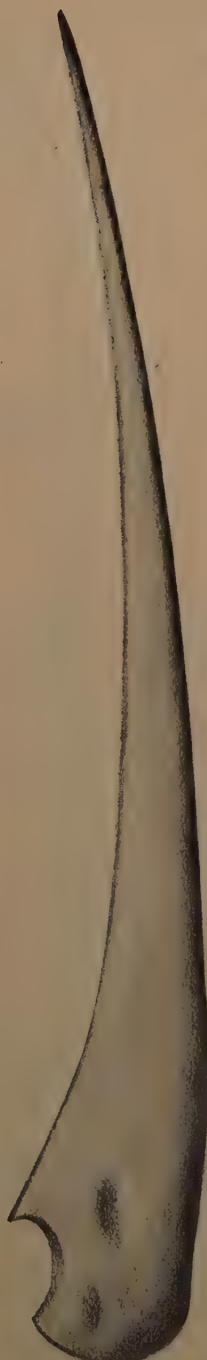


332

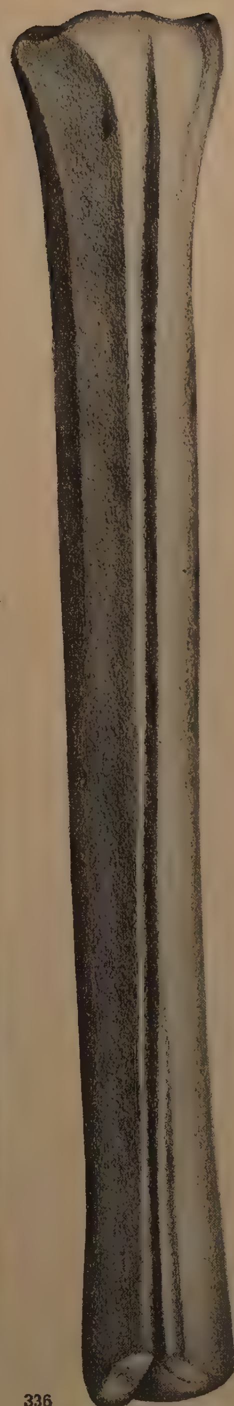


333

334



335

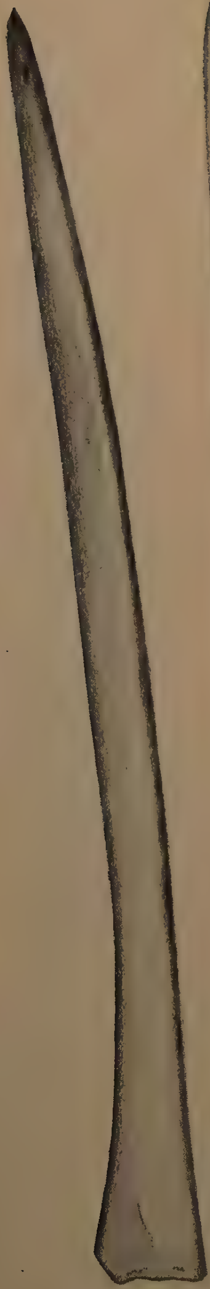


336

337

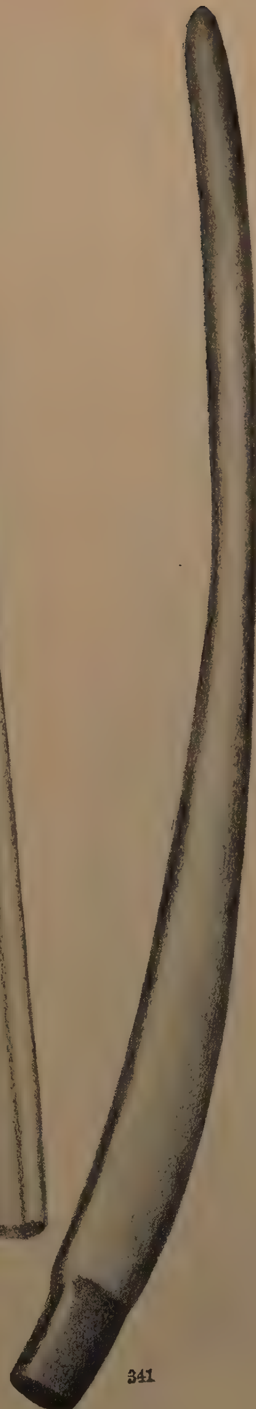
338

Plate 39



339

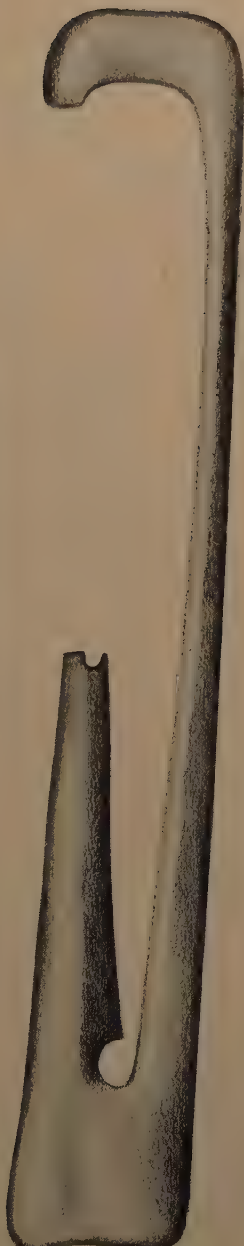
340



341

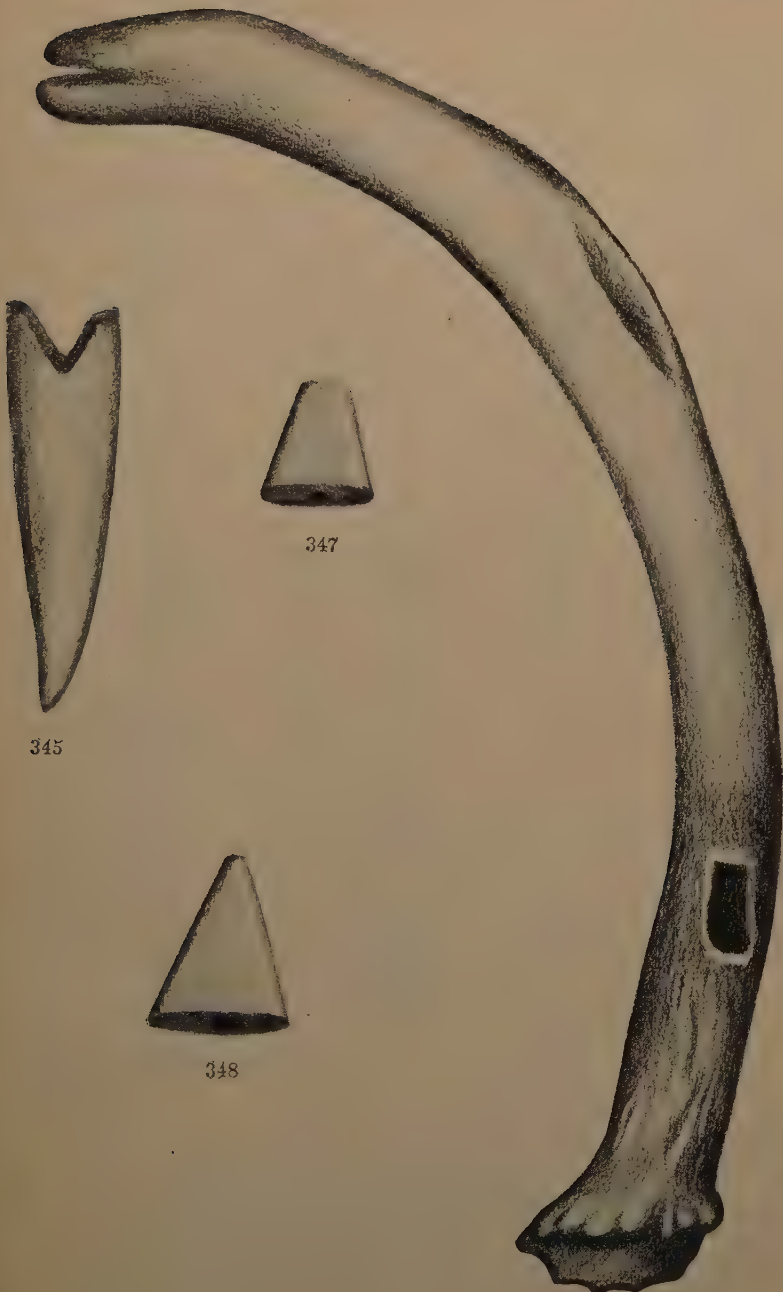
Plate 40

342



343

344



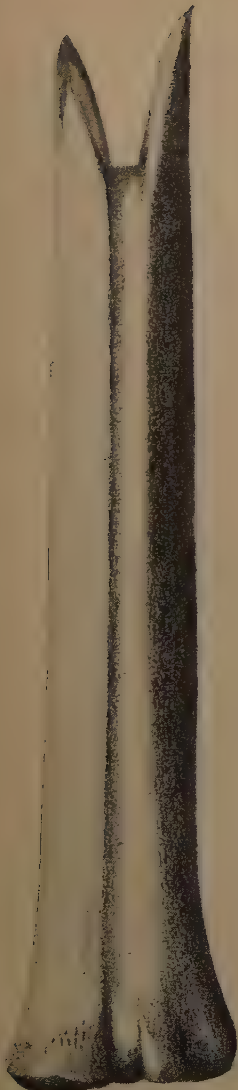
347

345

348

346

Plate 42



349

350

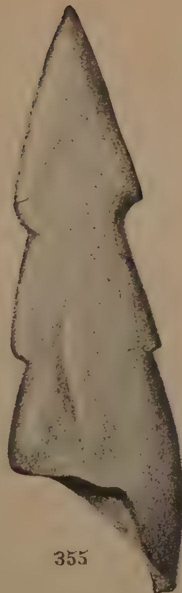
351

352

353

Plate 43

354



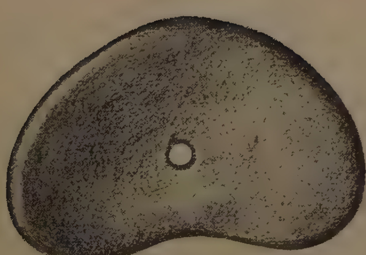
355

356

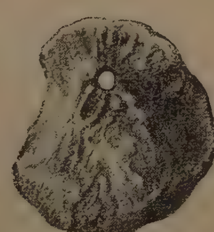
357

358

359



360



361

INDEX

The superior figures tell the exact place on the page in ninths; e. g. 278^3 means page 278, beginning in the third ninth of the page, i. e. about one third of the way down.

(*Pages 351-352 were bulletin cover pages*)

University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 51 April 1902

CATALOGUE

OF

NEW YORK REPTILES AND BATRACHIANS

BY

EDWIN C. ECKEL

AND

FREDERICK C. PAULMIER Ph.D.

University of the State of New York

New York State Museum

Frederick J. H. Merrill Director

Bulletin 51 April 1902

CATALOGUE OF

NEW YORK REPTILES AND BATRACHIANS

PREFACE

Since the publication, by James E. De Kay,[1] of his report on the zoology of New York in 1842, and by Spencer F. Baird,[2] of the report on the serpents of New York state, great changes have been made in the nomenclature and classification of the reptiles and batrachians, and a number of new species and subspecies have been added to our fauna. The works named are, moreover, practically unobtainable, and no popular discussion of the subject is at present in print. The groups here treated are, in consequence, much less familiar to the general student than are the birds and mammals.

In view of these facts, it seemed desirable for the New York state museum, in pursuance of its definite policy of placing at the disposal of the citizens of this state trustworthy guides to the various biologic groups, to issue a catalogue of the New York species of reptiles and batrachians as at present known, accompanied by descriptions sufficient to make it possible for nonspecialists to identify these species. At the request of the director, this work was undertaken by the authors of the two papers published in the present bulletin.

Information regarding the occurrence and distribution of the various species is much to be desired; and local faunal lists would be of much value in this connection, while specimens sent to the state museum will be identified. Frederick J. H. Merrill

[1] De Kay, James E. Zool. N. Y. v. 3, pt 3, 1842.

[2] Baird, Spencer F. Serpents of New York. N. Y. state cab. nat. hist. 7th an. rep't. 1854.

SERPENTS OF NORTHEASTERN UNITED STATES

BY EDWIN C. ECKEL

INTRODUCTION

The following catalogue was commenced with the intention of including only such species of serpents as have been found within the limits of New York state, together with such other species as could, from occurrences in adjoining states, be reasonably expected to occur here. A preliminary check list, prepared on that basis by the author, and published recently in the *American naturalist*, contained 25 species and subspecies. This list was notably imperfect, of which fact no one was more conscious than its author; but it was the first attempt to formulate such a catalogue since Baird's list of 1854.

De Kay, in 1842, described 15 species of snakes as occurring in this state. To this list Gebhard added a sixteenth (Storeria occipitomaculata) in 1851, and a seventeenth (Sistrurus catenatus catenatus) in 1853. The present list names 19 species as inhabitants of New York state, one of these species however being represented by six subspecies. One additional species, (Coluber vulpinus) is added because of a single occurrence in Massachusetts; while the three remaining species have been found in Pennsylvania or New Jersey, but not in New York.

The total number of species and subspecies here described is 28, and the catalogue, as now issued, includes every species and subspecies authentically recorded from that portion of the United States lying north of Maryland and east of Ohio. Two additions may have to be made to this list in the near future. It is probable that some more southern representative of Osceola doliata than O. d. triangula will be found to occur in New Jersey or Pennsylvania; while there is a possibility that some of the Ohio specimens (from Lake Erie) identified as Natrix fasciata erythrogaster may really prove to be of that subspecies.

As noted later in this bulletin, I am greatly indebted to Messrs H. D. Reed of Cornell university, and W. Seward Wallace of New York, for hitherto unpublished data which they have placed at

my disposal. Mr Reed has further aided me by sending specimens from several localities in this state. It seems proper to point out here that Mr Wallace, in securing Cyclophis aestivus and Pityophis melanoleucus near Nyack N. Y., has made the first real addition to our local faunal list since 1853.

All the figures in this bulletin save those on pl. 1 are duplicates of those used in Cope's *Crocodilians, lizards and snakes of North America*, and are available for use here through the courtesy of the secretary of the United States national museum.

Reference list

The following list is not in any way complete, but it contains all faunal lists, relating to the area under consideration, noticed by the author. Several of the more important general works on American herpetology have been added because of localities given in their texts; and, in addition, certain papers by Cope have been cited because of their bearing on the matter contained in the section on variation. For explanation of asterisks, see p. 389.

The works are referred to in the bulletin by author and date.

*__Abbott, C. C.__ '68. Catalogue of the vertebrate animals of New Jersey. Geol. N. J. p. 801–3.

*__Allen, Glover M.__ '99. Notes on the reptiles and batrachians of Intervale, New Hampshire. Bost. soc. nat. hist. Proc. 29 : 63–75.

*__Allen, J. A.__ '69. Catalogue of the reptiles and batrachians found in the vicinity of Springfield, Mass.: with notices of all the other species known to inhabit the state. Bost. soc. nat. hist. Proc. 12 : 171–204.

__Baird, Spencer, F.__ '54. On the serpents of New York; with a notice of a species not hitherto included in the fauna of the state. N. Y. state cab. nat. hist. 7th an. rep't, p. 95–124.

*__Bicknell, E. P.__ '82. Review of the summer birds of a part of the Catskill mountains, with prefatory remarks on the faunal and floral features of the region. Linn. soc. N. Y. Trans. 1 : 113–68.

*__Cope, Edward Drinker.__ '75. Check list of North American Batrachia and Reptilia. U. S. nat. mus. Bul. 1, p. 104.

——— '92. Critical review of the characters and variations of the snakes of North America. U. S. nat. mus. Proc. 14 : 589–694.

——— '93. The color variations of the milk snake. Am. nat. 27 : 1066–71, pl. xxiv–xxvii.

——— '96. [Variations in Osceola doliata] Primary factors of organic evolution. N. Y. p. 29–41, fig. 2–11.

*——— 1900. Crocodilians, lizards and snakes of North America. U. S. nat. mus. Rep't. 1898. p. 153–1270, pl. 1–36.

*__De Kay, James E.__ '42. Natural history of New York; Zoology of New York. v. 3, pt 3, Reptiles and amphibia. 2 v. Alb.

Ditmars, Raymond L. '96. Snakes found within fifty miles of New York. Linn. soc. N. Y. Abstract and proc. no. 8, p. 9–24.

Eckel, Edwin C. 1901. Snakes of New York: an annotated check list. Am. nat. 35 : 151–55.

***Fogg, B. F.** '62. List of reptiles and amphibians found in the state of Maine. Portland soc. nat. hist. Proc. 1 : 86.

Gebhard, John, jr. '51. [Occurrence of Storeria occipitomaculata in New York state] N. Y. state cab. nat. hist. 4th an. rep't, p. 23.

——— '53. [Occurrence of the Massasauga, Crotalophorus tergeminus in New York state] N. Y. state cab. nat. hist. 6th an. rep't, p. 22.

***Holbrook, J. E.** '42. North American herpetology. 5 v. Philadelphia 1842.

***Hough, Franklin B.** '52. Catalogue of reptiles and fishes, from St Lawrence county, procured for the state cabinet of natural history by Franklin B. Hough. N. Y. state cab. nat. hist. 5th an. rep't, p. 23–28.

***Jordan, David S.** '99. Manual of the vertebrate animals of the northern United States. Chicago. 1899.

***Kirtland, Jared P.** '38. Report on the zoology of Ohio. O. geol. sur. 2d an. rep't. p. 155–200.

***Linsley, James H.** '44. Catalogue of the reptiles of Connecticut. Am. jour. sci. 1st ser. 46 : 37–51.

***Macauley, James.** '29. [Serpents of New York state] Natural, civil and statistical history of the state of New York, by James Macauley. 3 v. O. 1 : 441, 513–17.

***MacKay, A. H.** '96. Reptiles and batrachians of Nova Scotia. Nova Scotian inst. of sci. Proc. ix : xli–xliii.

***Mearns, Edgar A.** '98. A study of the vertebrate fauna of the Hudson highlands. Am. mus. nat. hist. Bul. 10 : 303–52.

——— '99. Notes on the mammals of the Catskill mountains, New York, with general remarks on the fauna and flora of the region. U. S. nat. mus. Proc. 21 : 341–60.

***Morse, Max.** 1901. Ohio reptiles in the Ohio state university zoological museum. Ohio naturalist. 1 : 126–28.

***Nelson, Julius.** '90. Descriptive catalogue of the vertebrates of New Jersey. State geol. N. J. Final rep't. v. 2, pt 1, p. 648–48.

Putnam, F. W. '65. [On the species of the genus Eutaenia B. & G.] Bost. soc. nat. hist. Proc. 9 : 60–62.

——— '66. [Occurrence of worm snake in New England] Essex inst. Proc. iv : lxxxiii–lxxxiv.

***Reed, H. D.** 1901. Notes on the snakes of the vicinity of Ithaca, N. Y. (Manuscript placed at my disposal by the author)

***Smith, David S. C. H.** '33. [Catalogue of the] Reptilia [found in Massachusetts] Rep't geol. Mass. 1833. p. 552, 2d ed. 1835, p. 534.

***Smith, W. H.** '82. Report on the reptiles and amphibians of Ohio. O. geol. sur. Rep't. v. 4. Zoology and botany, p. 629–734.

Stejneger, Leonhard. '95. Poisonous snakes of North America. U. S. nat. mus. Rep't. 1893. p. 337–487, pl. 1–19.

——— 1901. Eckel's Snakes of New York. Am. nat. 35 : 428.

*Storer, D. H. '39. Reports on the fishes, reptiles and birds of Massachusetts. Bost. p. 221–34.

*Thompson, Zadock. '42. [Serpents of Vermont] History of Vermont, natural, civil and statistical, by Zadock Thompson. p. 115–19.

*Verrill, A. E. '65. Catalogue of the reptiles and batrachians found in the vicinity of Norway, Oxford co. Maine. Bost. soc. nat. hist. Proc. ix : 195–99.

——— '69. [Note on occurrence in Connecticut and Massachusetts of Ancistrodon contortrix] Bost. soc. nat. hist. Proc. xii : 249.

Wallace, W. S. 1901. Snakes of Rockland co., N. Y. Trans. Linn. soc. N. Y.

Placed at my disposal, in manuscript form, by the author, and as yet unpublished.

CLASSIFICATION AND NOMENCLATURE

The paper here presented is designed for general use, and is issued as a guide to our local species of serpents, with a view to obtaining farther data concerning the occurrence, frequency and variations of these species in different parts of the area under consideration. In order to popularize the subject as far as possible, certain changes from the usual form of presentation have been adopted.

In giving the specific descriptions, synonymic lists have been omitted, and the scientific names under which each species is described by De Kay ('42) and Jordan ('99) respectively have been added. In addition to an artificial generic key of the common type, based on structural characters of more or less moment, a highly artificial key to the species, based so far as possible on tint and pattern of coloration, has been devised; which will be of service in determinations of living specimens.

Prof. Cope's grouping and terminology, as fully developed in his last work (Cope. 1900) on North American serpents, have been strictly adhered to. This close following of what will undoubtedly be for many years the standard general work on the subject, seemed desirable in a paper such as the present, purely preliminary in its nature, though the author's views on several of the forms treated are widely at variance with those advanced by Prof. Cope.

To the scientific name of each species, has been added that one of its common names which seems to be in most general use, or

which designates most correctly some character. In the few cases where such names did not exist, descriptive names have been coined.

Anatomic characters

Serpents, or snakes, are reptiles with highly elongate, cylindric bodies, covered with scales, this covering being shed entire at certain seasons of the year. External limbs are either, as in our species, entirely wanting, or very rudimentary. The mouth is capable of great distension, most of the bones of the head being united by ligaments or muscles only, and possessing therefore great freedom of motion. External ears are lacking; as are eyelids, the eye being protected by an immovable layer of transparent epidermis, which is shed with the skin. The tongue is forked, capable of protrusion, and retractible into a sheath. Teeth are always present, on both palatine bones and jaws. The digestive and respiratory organs are, like the general form, much elongated. The paired organs (lungs, etc.) are rarely bilaterally symmetric, one of the pair being usually rudimentary or wanting. The stomach is a simple enlargement of the digestive canal.

The snakes form a very compact and well marked group, easily separable by external characters from the nearest related forms. Among the lizards, it is true, certain serpentiform species occur, but not within the region covered by this paper.

But little definite information is at hand concerning the breeding habits of our snakes, even of the more common species. It is known that certain species are oviparous (laying eggs) while others are ovoviviparous (the egg being developed and the young hatched before exclusion from the body of the mother). From the scanty data obtainable it seems probable that the New York species belonging to the genera Coluber, Zamenis, Cyclophis, Liopeltis, Osceola and Ophibolus are all oviparous; while in those of Storeria, Natrix, Eutaenia, Ancistrodon, Sistrurus and Crotalus the young are brought forth alive, owing to an early breaking of the eggshell. The manner of birth of the species of Diadophis, Carphophiops and Pityophis is unknown; and it seems possible that in Heterodon platyrhinus both forms of birth may occur.

Venomous and nonvenomous snakes

Of the species occurring within the area here discussed, only three are venomous. These are the banded, or northern rattlesnake (p. 387); the massasauga, or prairie rattlesnake (p. 386); and the copperhead (p. 385). The three venomous species are closely related, all belonging to the family of Crotalidae, or pit-vipers, marked by the presence of erectile poison fangs on the upper jaw and by the presence of a deep pit between the eye and the nostril. The head is more or less markedly triangular in outline, and separated from the body by a relatively constricted neck. The rattles of the two species of rattlesnakes are of course an unmistakable characteristic. The copperhead bears no such distinguishing mark, and is frequently confused with the harmless hog-nosed snake, or blowing adder (p. 368), the water snake (p. 377) and occasionally even with the familiar milk snake (p. 374). A careful reading of the descriptions and inspection of the cuts given of these species, and comparison with those of the copperhead will make the points of difference clear.

Much attention has naturally been paid to the Crotalidae by American authors, and numerous papers on the subject have been published. By far the most valuable and comprehensive work on the venomous snakes of North America is that by Dr Leonhard Stejneger ('95), curator of reptiles and batrachians at the United States national museum, to which the reader is referred for a very detailed discussion of our poisonous snakes.

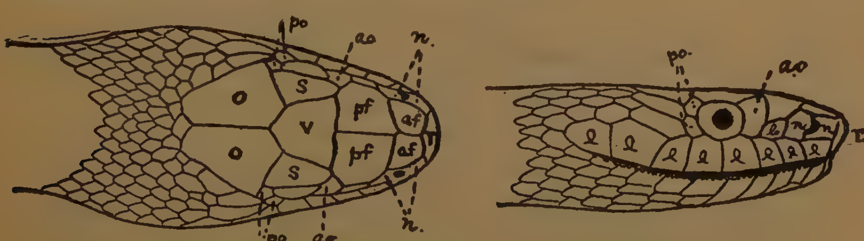


Fig. 1 Illustrating nomenclature of the head scales of serpents

Nomenclature of the scales

Certain terms frequently used in describing the characters of the species require definition here.

The vertical or frontal plate (*v*) is the central, shield-shaped plate

in the middle of the head above; on either side of it are the superciliary plates (*s*) lying immediately above the eye. The pair of plates immediately in front of the vertical are the prefrontals (*pf*); in front of these lie the internasals (*af*), while the plate terminating the muzzle, and lying in front of the prefrontals, is the rostral (*r*). The plates behind the superciliaries and vertical are the occipitals (*o*). The plates immediately behind the eye are the postoculars, or postorbitals (*po*); those in front of the eye are the preoculars, anteoculars or anteorbitals (*ao*), in front of which are the loreals (*lo*). Between the loreal and the rostral, and inclosing the nostril, are the nasal plates (*n*). The superior labials (*l*) margin the upper jaw; the inferior labials (not marked in figure) margin the lower jaw. The temporal plates lie between the superior labials and the occipitals.

The plates on the under side of the body, from the neck to the vent, are the abdominal plates, or gastrosteges; those from the vent to the end of the tail are the subcaudal plates, or urosteges. The *anal plate* is that immediately anterior to the vent. It may be entire, or divided by a longitudinal parting; and this difference is of value in the determination of the various snakes, as will be seen by reference to the artificial key to the genera (p. 364). The term, "scales in . . . rows," will often be found in the specific descriptions, the number of rows referred to in such case being the number of longitudinal rows of scales, excluding the abdominal series. *Keeled* or *carinate* scales show a ridge on the median line.

Variation

Of late years much attention has been paid by naturalists to the subject of variation in animals, and certain relations between color variations and geographic distribution seem to be well established.

Certain species of snakes show variations in color and color pattern to a remarkable degree, notable examples of this being the common garter snake and the familiar, though somewhat scarcer, milk snake. Prof. E. D. Cope paid particular attention to the variations in these species, and has discussed the subject in a long series of papers several of which are cited in the accompanying reference list (p. 357). As noted earlier in this bulletin (p. 359) the grouping adopted in the present paper follows the views which he advanced

in his last discussion (Cope. 1900) of the forms mentioned. It would seem, however, that of the species occurring within the area here considered Eutaenia sirtalis and Osceola doliata and, to a somewhat less degree, Natrix fasciata, require careful revision. With the scanty material at hand this is not possible at present for even the New York forms of those species, but a few very general notes will be found among the specific descriptions.

Melanism, more or less complete, has been noted briefly under the two of our species which seem to be most subject to it. In Heterodon platyrhinus (p. 368) the black coloration has undoubtedly no systematic importance. In regard to Natrix fasciata sipedon (p. 377), however, the case is somewhat different, as it would seem probable that in New York and New England specimens the darker coloration is general and not merely individual in its nature.

DISTRIBUTION

But little is known concerning the distribution throughout the state of the species here described. This lack of knowledge is particularly unfortunate because the reptiles, owing to their relatively low degree of mobility and restricted individual range would certainly seem to offer a much better basis for the definition of the faunal zones of any area than the birds or mammals. Local faunal lists giving details regarding the occurrence and abundance of the various species in different localities are therefore much to be desired. Such information on this subject as is now at hand has been appended to the specific descriptions. These brief notes are based on published papers by Dr Edgar A. Mearns ('98, '99), R. L. Ditmars ('96) and the author (1901); and on a manuscript list (1901) of the species found near Ithaca N. Y., which has been very kindly placed at my disposal by H. D. Reed, of Cornell university. A paper on the snakes of Rockland co. N. Y. (soon to be published in the transactions of the Linnaean society of New York) has also been placed in my hands in manuscript by its author, W. Seward Wallace, for use in the present bulletin. It will be noted that nearly all our information, therefore, relates to the eastern and more particularly the southeastern portion of the state. With the exception of Mr Reed's notes, I have only scattered data on occurrences in the central and northern portions of the state,

while not a single record has been obtained from the southern tier of counties adjacent to the Pennsylvania border. In view of the number of educational institutions and local scientific societies in New York state, it seems curious that so little attention has been paid to this question. Data on the subject will be very acceptable to the author, who will also be glad to identify specimens sent to the state museum. Directions for collecting will be found in another section of this bulletin (p. 407).

Key to genera

The following artificial key to the families and genera of the species of snakes occurring in the area discussed is based on structural characters, often of slight systematic value, and follows closely the lines of the generic key in Jordan ('99).

COLUBRIDAE

A. No pit between eye and nostril; upper jaw with small teeth; neck not constricted; head more or less elongate; top of head covered with plates; form, in general, slender

- *a* Dorsal scales carinated
  - 1) Anal plate entire
    - *a*) Scales in 19–21 rows........................ Eutaenia (p. 381)
    - *b*) Scales in 27–31 rows.................. ... Pityophis (p. 373)
  - 2) Anal plate bifid
    - *a*) Scales in 15–17 rows
      - * Tail one third or more of total length. Cyclophis (p. 369)
      - ** Tail less than one third of total length.. Storeria (p. 380)
    - *b*) Scales in 19–27 rows
      - * Rostral recurved; scales in 25 rows.. Heterodon (p. 368)
      - ** Rostral not recurved; gastrosteges less than 170............................ Natrix (p. 376)
      - *** Rostral not recurved; gastrosteges more than 170........... .... Coluber (p. 371)
- *b* Dorsal scales smooth
  - 1) Anal plate entire
    - *a*) Head flattened........................ ... Osceola (p. 374)
    - *b*) Head conical .... Ophibolus (p. 375)
  - 2) Anal plate bifid
    - *a*) Scales in 17 rows....... .... Zamenis (p. 370)
    - *b*) Scales in 13 rows; head not distinct.. Carphophiops (p. 366)
    - *c*) Scales in 15 rows; superior labials 8....... Diadophis (p. 367)
    - *d*) Scales in 15 rows; superior labials 7........ Liopeltis (p. 369)

CROTALIDAE

B. Deep pit between eye and nostril; upper jaw with erectile poison fangs; form stout; head more or less triangular; neck constricted; subcaudals entire

a Tail without rattle........................... Ancistrodon (p. 385)

b Tail with small rattle; top of head covered with plates.......................... Sistrurus (p. 386)

c Tail with larger rattle; top of head covered with small scales.......................... Crotalus (p. 387)

Color key to species

The author has prepared a purely artificial key, based almost entirely on color and pattern, which is here appended. As it does not require handling of the specimen, it furnishes a convenient means of identifying live specimens whose specific character is in doubt. The numbers at the right refer to the similarly numbered specific descriptions which begin on p. 366 of this bulletin.

Owing to the great variation in color and pattern sometimes shown by individual specimens, identifications made by means of any key based purely on these characters must not be accepted as decisive, but should be verified by reading over the characters given in the specific descriptions, under the head of that species to which the key seems to point; and by careful comparison of the specimen with the figure given for each species.

a Color of back uniform; no marked spots, blotches or stripes

Color green; scales smooth.......................... 4

Scales rough.......................... 5

Color black; no lighter markings.......................... 6

Some scales white-edged.......................... 8

Conspicuous yellowish neck ring.......................... 2

Color reddish brown; below pink; head not distinct from body.......... 1

Color chestnut brown; below pink; head distinct from body.......... 17

Below grayish.......................... 16

b Striped longitudinally; with or without additional spots

Striped black and brown; no spots.......................... 14

Brown and yellow; no spots; abdomen unicolor; very slender.. 18

Olivaceous and yellow or brown; dark spots on back and sides in several rows.......................... 20

Greenish brown and brown; below reddish yellow, with dark spots.......................... 13

c Spotted, blotched or transversely banded above

1) No rattle; head tapering into neck and body, not triangular

Color black, with narrow yellow cross lines; head black, spotted yellow 11a
Brown to dark gray, with darker blotches; below clouded with reddish or yellowish 12a
Reddish to purplish brown, darker blotches; below red, black spotted 15
Light brown, with chocolate blotches; below yellowish white, black blotched 7
Gray to brown, with dark blotches; below yellowish to greenish yellow; rostral recurved 8
Ashy gray, with brown saddle spots; below tesselated with black 10a
Whitish, with chestnut blotches black margined; below yellowish 9
Olivaceous to brownish, with black spots; below greenish white 20b

2) No rattle; head markedly triangular; neck constricted, distinct from body

Color brownish, with darker blotches; top of head copper red; below yellowish, with dark spots 21

3) Tail terminating in a rattle; head very distinct, triangular, neck constricted

Head covered with many small scales 23
Head with a few large plates 22

A. COLUBRIDAE

Top of head covered with plates; no pit between eye and nostril; upper jaw with normal (solid) teeth, no poison fangs; neck not markedly constricted; head more or less elongate; subcaudals divided. Species all harmless.

1 Carphophiops amoenus (Say)

Worm snake

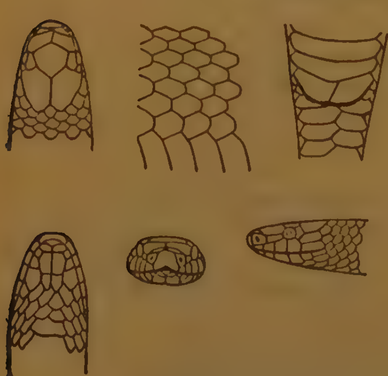


Fig. 2 Carphophiops amoenus

De Kay. Calamaria amoena
Jordan. Carphophiops amoenus

Head small, not distinctly marked off from body, frontal plate hexagonal, nearly as broad as long. Tail short, tapering to a point. Scales all smooth, in 13 rows.

Above bright chestnut brown, very glossy; beneath, bright salmon color.

"Found under stones and logs." *De Kay.* '42

"Rare around Nyack. I have seen but one specimen, taken in 1899 at Blauveltville, Rockland co. N. Y." *Wallace.* 1901

Probably occurs quite commonly in all the northeastern states. Its small size, inconspicuous color, and habits render it difficult of detection, however. It is commonly found under stones or logs, or in fields during plowing.

2 Diadophis punctatus (Linn.)

Ring-necked snake

De Kay. Coluber punctatus
Jordan. Diadophis punctatus

Head much depressed, flattened above; snout rounded; body slender; tail tapering. Scales in 15 rows.

Bluish black above, with a yellow or yellowish white ring about neck; yellowish beneath, sometimes with spots. Length 18 inches.

"Found in every part of the state. Common under rocks and stones, and frequently seen under the bark of decayed trees." *De Kay,* '42, p. 40

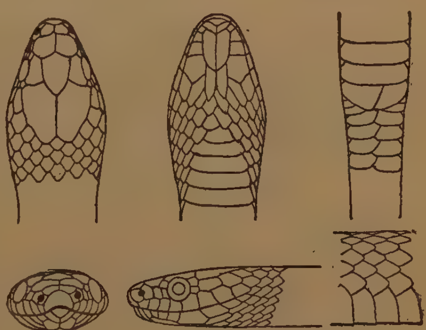


Fig. 3 Diadophis punctatus

"Quite numerous." *Mearns.* '98, p. 326

"Rare (near Ithaca)." *Reed.* 1901

"Quite frequent in Rockland county. I captured a single specimen at Coldspring Harbor, Long Island, in August, 1899." *Wallace.* 1901

This snake may be common in southeastern New York, but it is rarely seen. I have secured but a single specimen in that region, taken in June 1901 near Fishkill village, Dutchess co. N. Y.

3 **Heterodon platyrhinus** Latreille

Blowing adder

De Kay. Heterodon platyrhinos
Jordan. Heterodon platyrhinos

Body short and stout, tail very short and rapidly tapering. Scales markedly carinated. Rostral compressed and recurved. Scales in 25 rows.

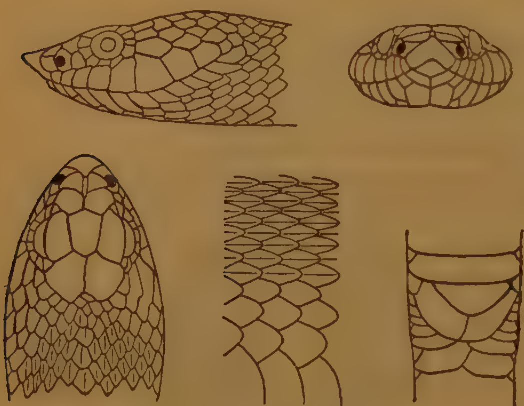


Fig. 4 Heterodon platyrhinus

Color yellowish gray to brown, with dark brownish to black blotches on back, becoming black, half rings on upper side of tail; beneath, yellowish to greenish yellow. Length 30 inches.

Melanistic individuals of this species seem to be quite common. They are recorded by Cope from Scarboro, Westchester co.; and have been taken by R. L. Ditmars in Sullivan county.

"Rather common in the southern parts of New York." *De Kay.* '42

"One of our common snakes" in the Highlands. *Mearns.* '98, p. 327

"Very common in sandy regions in Orange county and southern Westchester county." *Eckel.* 1901, p. 152

"Not at all common in Rockland county." *Wallace.* 1901

This species, though entirely harmless, is commonly regarded as venomous. When annoyed it flattens the anterior portion of its body, and hisses vigorously. Comparison of the above specific description and figures with those of the copperhead (p. 335) will show the numerous points of difference.

4 **Liopeltis vernalis** (De Kay)

Smooth green snake

De Kay. Coluber vernalis
Jordan. Liopeltis vernalis

Head distinct; body slender. Scales smooth, in 15 rows. Tail less than one third of total length.

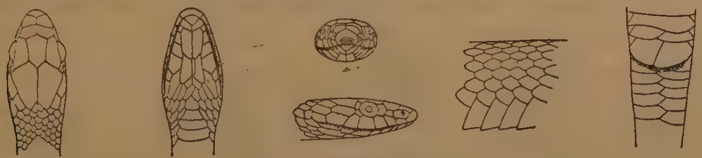


Fig. 5 Liopeltis vernalis

Above, green; yellowish to yellowish green beneath. Length 20 inches.

A somewhat smaller species than Cyclophis aestivus from which it is distinguished by its scales being smooth and in 15 rows, as well as by having a proportionately shorter tail.

Common in many parts of the state. De Kay '42, states that it is "very common in the marshes about Salina and Cayuga."

"Specimens taken on Staten Island, N. Y." *Ditmars.* '96, p. 14

"Still common in the Highlands." *Mearns.* '98, p. 326

"More common, I believe, in Orange county than east of the Hudson." *Eckel.* 1901, p. 152

"A number of specimens taken at Ithaca." *Reed.* 1901

"Quite common in Rockland county." *Wallace.* 1901

Specimens were taken by Baird near Westport, Essex co., and several have been sent to the state museum recently from Ausable Forks, Essex co. The species has been recorded as far north as Nova Scotia. (*MacKay.* '96.)

5 **Cyclophis aestivus** (Linn.)

Rough green snake

De Kay. Leptophis aestivus
Jordan. Opheodrys aestivus

Head distinct; body slender. Scales strongly carinated, in 17 rows. Tail more than one third length of body.

Bright green above; light yellow below. Length 30 inches.

Distinguished from Liopeltis vernalis, our only other snake

resembling it in color, by having keeled scales in 17 rows; while L. vernalis has smooth scales, in 15 rows.

Commonly described as not occurring north of central New Jersey, but Ditmars ('96, p. 15) found it "quite common" in Plymouth county, Ct.

Mr W. Seward Wallace, in his paper on the snakes of Rockland county N. Y., mentions its occurrence in that area; and in a recent

Fig. 6. Cyclophis aestivus

letter to me states that he does "not believe it to be rare, though it is not often seen, owing to its small size and secretive habits." In view of these records it is probable that the species will be found to occur in all the other southeastern counties, or at least in Westchester county and on Long Island.

6 Zamenis constrictor (Linn.)

Black snake

De Kay. Coluber constrictor
Jordan. Bascanion constrictor

Head distinct; body elongate. Scales smooth, in 17 rows. Color, in adult: lustrous pitch-black above; beneath, greenish black to

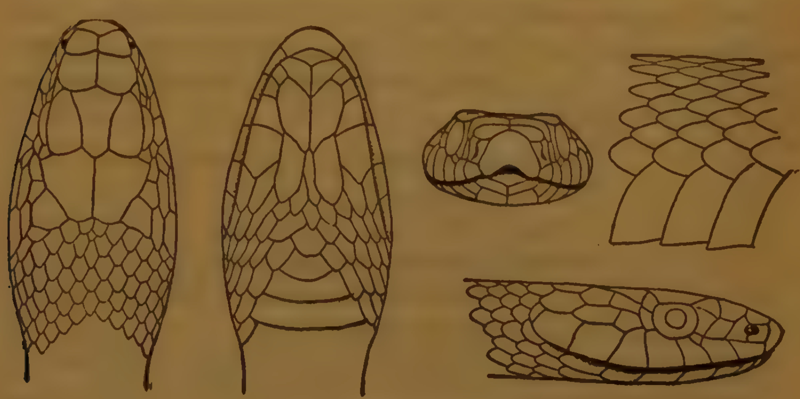


Fig. 7 Zamenis constrictor

yellow. Young, olive, with darker dorsal blotches. Length 50–60 inches.

"Formerly extremely abundant, now fairly so. A specimen taken May 25, 1883, measured 58 inches in length." *Mearns.* '98, p. 326

"A very common species, both relatively and absolutely, in southeastern New York." *Eckel.* 1901, p. 152

The department records show no evidence of a black snake having been taken in the vicinity of Ithaca since 1883. In all my collecting about here, for the past three years, I have never seen or heard of one. If any have been taken recently, the fact has not come to our notice. *Reed.* 1901

"Very common in Rockland county, attaining a large size." *Wallace.* 1901

7 **Coluber vulpinus** (B. & G.)

Fox snake

Jordan. Callopeltis vulpinus

Rostral broad; vertical plate broader than long. Scales in 27 rows (or occasionally 25); the nine dorsal rows carinated.

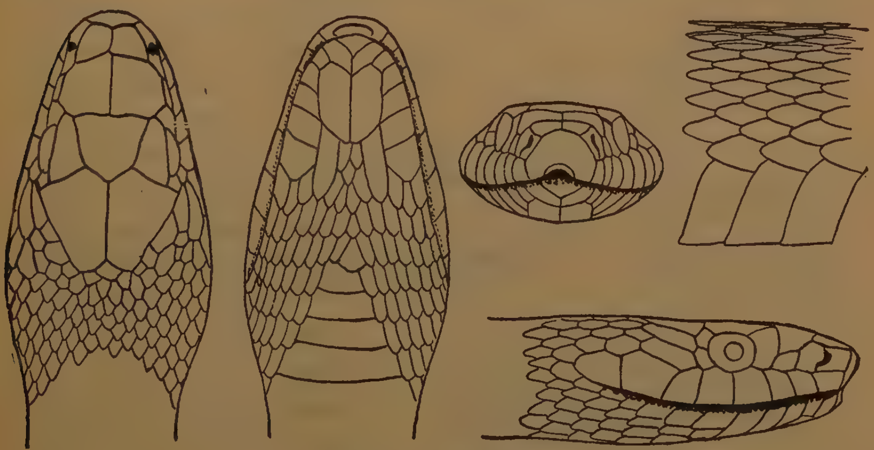


Fig. 8 Coluber vulpinus

Ground color above light brown, with a series of broad, transverse, quadrate, chocolate blotches; below yellowish white, with a series of subquadrate, black blotches on edge of abdomen, opposite to those of the dorsal series. Length 60 inches.

Included here because of one specimen, described by J. A. Allen

('69, p. 181) as captured in 1861 at Wenham Mass. No other specimen has ever been found within the area here discussed, and Cope (1900) states that it does not occur east of Illinois. Morse (1901), however, notes specimens from Ohio.

8 Coluber obsoletus obsoletus (Say)

Racer

De Kay. Coluber alleghaniensis
Jordan. Callopeltis obsoletus

Scales in 27 rows, the 17 dorsal rows keeled.

Color above, black or dark brown, with or without darker quadrangular blotches; occasional scales with white markings; greenish white to slate color below. Length 50–75 inches.

Found in the Highlands. *De Kay*, p. 37

"Formerly quite common; now rare." *Mearns*. '98, p. 327

"Occurs in Orange county (and probably east of the Hudson), though much scarcer than Zamenis constrictor. *Eckel*. 1901. p. 152

"Specimens captured near Ithaca, June 4, 1883, and summer of 1889; at Chittenango, by D. G. Gates, Ap. 27, 1889. A specimen 150 cm long captured alive at Newfield was sent to Cornell university in August 1899." *Reed*. 1901

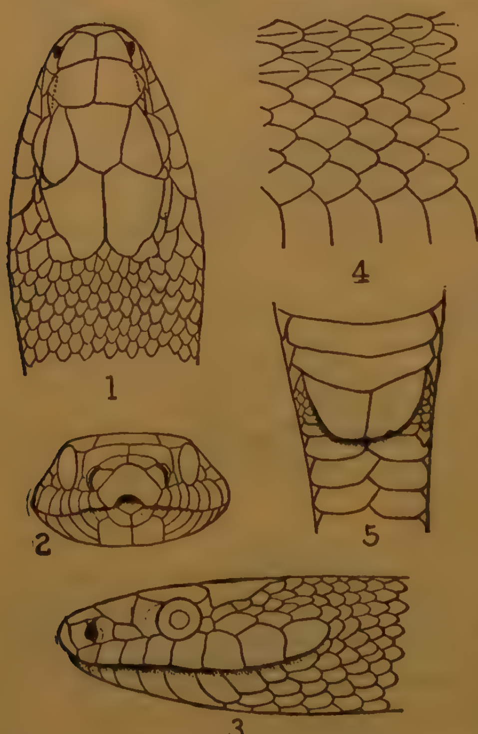


Fig. 9 Coluber obsoletus obsoletus

"Occurs in Rockland county." *Wallace*. 1901

9 Pityophis melanoleucus (Daudin)

Pine snake

De Kay. Pituophis melanoleucus
Jordan. Pituophis melanoleucus

Head short, elevated; rostral plate compressed and narrowed above. Scales in 27 to 31 rows, all save the outer four rows on each side being keeled.

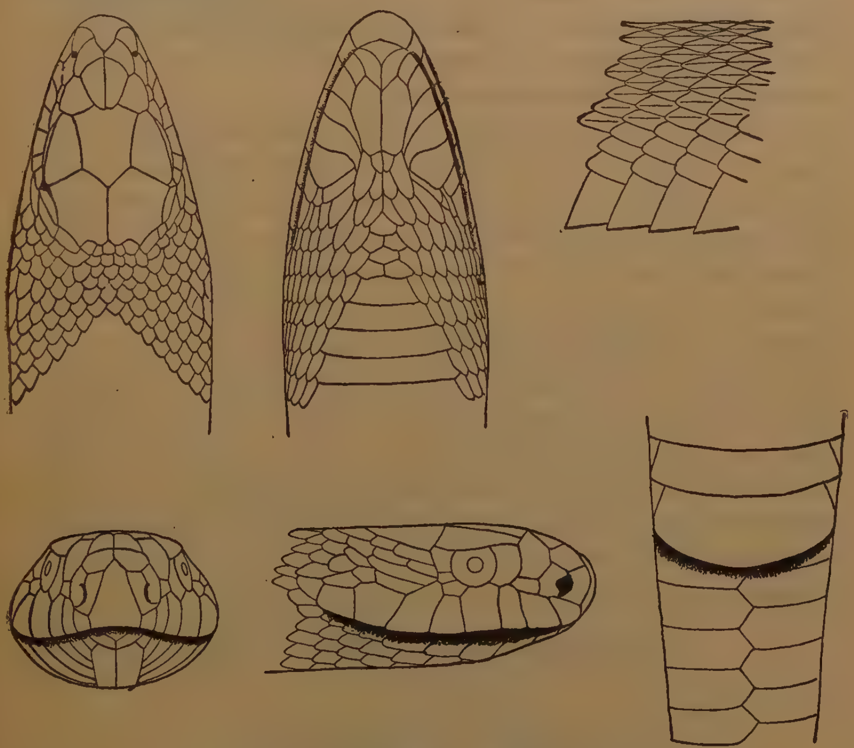


Fig. 10 Pityophis melanoleucus

Head spotted with black; color above whitish, with a series of chestnut brown blotches, margined with black; abdomen yellowish. Length 60 inches.

"I have seen but one of these snakes in Rockland county (on Tallman's mountain, near Nyack, at an elevation of about 500 feet A.T.), but it is said to be quite common in the county." *Wallace.* 1901

Mr Wallace's record is of great interest inasmuch as it verifies,

after the lapse of almost sixty years, De Kay's prediction that the species "will probably be found in this state." The pine snake may reasonably be expected to occur in Orange county also, but I have no record of it from that area.

10 **Osceola doliata** (Linn.)

Jordan. Lampropeltis doliatus

Scales in 21 rows: head flattish. Ground color above varying from ashen to bright yellow, but only appearing as transverse interspaces between the brown to reddish spots or saddles which cross the back. Length 30–50 inches.

Osceola doliata is one of our most variable species. The subject can not well be discussed in the present bulletin, and the reader is referred to Prof. Cope's papers, the more important of which are cited in the accompanying reference list, for a full presentation of his views. The subspecies next described — the familiar milk snake — is the only form of Osceola doliata occurring in New York. Several specimens in the state museum, however, taken near Albany N. Y. agree much more closely with Cope's O. d. clerica than with O. d. triangula. As Albany is well on toward the northern limit of Osceola doliata the significance of this variation in its bearing on Cope's views of the geographic distribution of the various "subspecies" is apparent. Specimens of the "milk snake" from any part of the state would on this account be particularly acceptable to the author.

10a **Osceola doliata triangula** (Boie)

Milk snake

De Kay. Coluber eximius
Jordan. Lampropeltis doliatus triangulus

Above yellowish gray, with a dorsal series of large brown to chocolate blotches, bordered with black. On each side, on the second to fifth rows of scales, is another series of similarly colored but smaller spots, alternating with the dorsal series. Still another series of blotches, entirely black, occur on the edges of the gastrosteges and the three lowest scale rows. On the head the ground color is exposed as a patch, triangular in outline, the apex being directed backward. Below yellowish white, tesselated with black.

"Generally distributed near New York city, but not common." *Ditmars.* '96, p. 13

"A very uncommon species" (in the Highlands.) *Mearns.* '98, p. 327

"A rather common snake in Orange county; less abundant, I believe, east of the Hudson." *Eckel.* 1901, p. 152

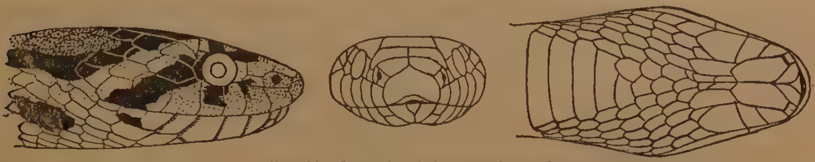


Fig. 11 Osceola doliata triangula

"Apparently not common in the immediate vicinity of Ithaca. Farther away from the town they appear to be more common." *Reed.* 1901

"Common in the villages and farming country of Rockland county." *Wallace.* 1901

11 **Ophibolus getulus** (Linn.)

Jordan. Lampropeltis getulus

Head little distinct, conic, not depressed, the muzzle slightly compressed and the rostral plate projecting beyond the lower jaw. Tail short. Scales smooth, in 21 to 25 rows.

Ground color black, marked above and below with yellow or white spots or bands. Top of head black, with white or yellow spots.

Several subspecies exist, the only form occurring within our limits, however, being that next described — Ophibolus getulus getulus.

11a **Ophibolus getulus getulus** (Linn.)

Chain snake

De Kay. Coluber getulus
Jordan. Lampropeltis getulus

Scales smooth, in 21–23 rows.

Head black, with yellow spots; color above black, crossed by about 30 narrow, continuous yellow lines, which bifurcate on the flanks; below, yellow, blotched with black. Length 50 inches.

"Not uncommon in the pine woods of New Jersey, and also found, but rarely, in what are called the brush plains of Long Island." *De Kay.* '42, p. 38

Hough, ('52, p. 23) in describing his collection made for the state museum in St Lawrence county, notes that this species is "of common occurrence in this section of the state." The specimens then sent in have disappeared, so that the record can not be verified; but, as I have stated, (1901) Gebhard, then curator, was competent to make the specific determination and would hardly have allowed an obvious error to be published. The species can not well be confused with any other New York form, and Hough's record can not

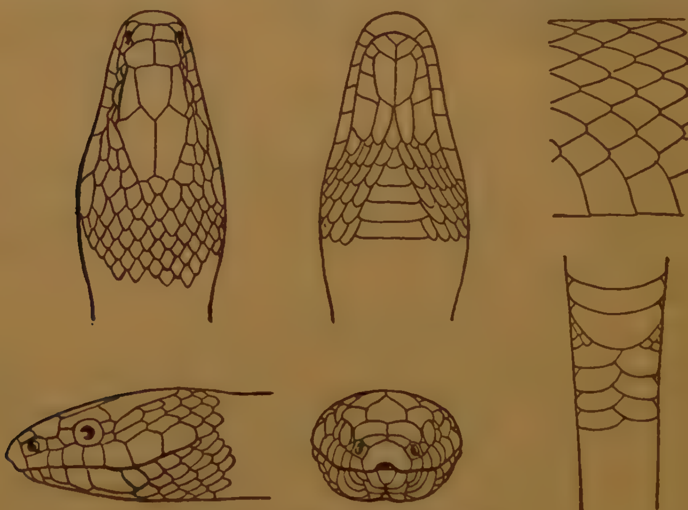


Fig. 12 Ophibolus getulus getulus

be neglected or suppressed; but, if true, the distribution thus given the chain snake is remarkable. Further data on this point would be of great service, and I would consider it a favor if some St Lawrence county naturalist would investigate the matter.

12 Natrix fasciata (Linn.)

Jordan. Natrix sipedon

Scales all carinated, in 23 or 25 rows. General form robust; tail not long. General color above bright reddish brown to gray, usually marked by large, dark brown, transverse spots; below yellowish or reddish, usually with more or less rounded spots of chestnut or reddish brown. Length 30–50 inches.

Of the "subspecies" listed by Cope, only one (N. f. sipedon) is definitely known to occur within our limits. Both W. H. Smith

('82) and Morse (1901), however, have reported Natrix fasciata erythrogaster from Ohio. The latter states that it is the most common form in certain localities on Lake Erie. The value of the identification is problematic, but as the localities are definitely given, and the specimens are now in the zoologic museum of Ohio state university, it would seem that the question could be conveniently and finally settled by submitting a suite to Dr Stejneger. The importance of these Ohio specimens in the present connection is that, if the subspecies is found as described by the authors noted, it may be expected to occur in western New York. The subspecies is marked off from all others of the Natrix fasciata by being unspotted both above and below, the coloration above being uniform reddish black, and below yellowish red.

12a **Natrix fasciata sipedon** (Linn.)

Water snake

De Kay. Tropidonotus sipedon
Jordan. Natrix sipedon

General color dull brown to dark gray, with darker transverse spots; below yellowish, with cloudy blotches of brownish or reddish. Length 30–50 inches. General form robust.

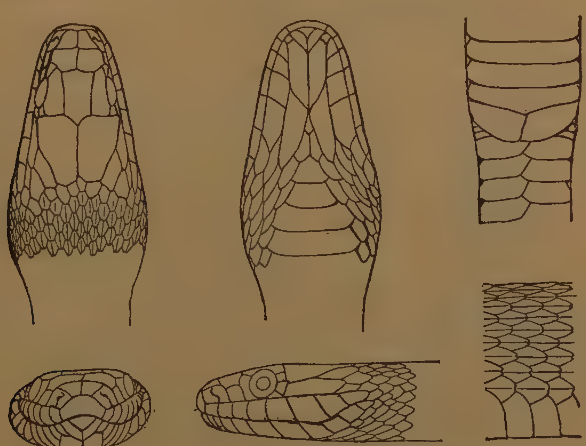


Fig. 13 Natrix fasciata sipedon

New York and New England specimens seem, in general, to be darker in coloration than those from more southerly areas. Holbrook's type of Tropidonotus niger came from New England

where, he says, the "species" was common. The water snake appears to be common throughout the state in ponds and streams, though rarely found away from their immediate vicinity. It is a particularly bad tempered species, but its bite is, of course, perfectly harmless. In its coloration and general form it bears some resemblance to the poisonous "moccasin" (Ancistrodon piscivorus) of the southern states, with which it is frequently confused. Its resemblance to the copperhead (Ancistrodon contortrix) (p. 385) is much less close.

"One of our largest, handsomest and most abundant snakes." *Mearns.* '98, p. 326

"Abundant in all the counties of southeastern New York." *Eckel.* 1901, p. 152

"Abundant near Ithaca; common at Hornellsville." *Reed.* 1901

"Often seen along the banks of the Hackensack and other streams in Rockland county, but not so common as the black snake." *Wallace.* 1901

13 Natrix rigida (Say)

Stiff snake

De Kay. Tropidonotus rigidus
Jordan. Regina rigida

Scales carinated, in 19 rows. Muzzle short. Upper surface of head flat. Above greenish brown, with two deep brown dorsal stripes; abdomen reddish yellow, with two series of deep brown to black spots. Length 24 inches.

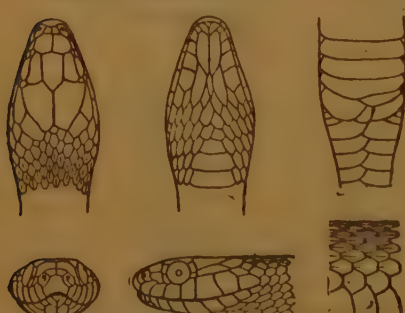


Fig. 14 Natrix rigida

Cope (1900, p. 959) mentions that this species ranges north to Pennsylvania.

14 Natrix leberis (Linn.)

Leather snake

De Kay. Tropidonotus leberis
Jordan. Regina leberis

Head small; little distinct from body; depressed and flattened. Scales carinated, in 19 rows.

Above chestnut brown, with a lateral yellow band, and three narrow black dorsal stripes; abdomen yellowish, with four brown longitudinal bands. Length 24 inches.

From description only, this species might possibly be confused with Eutaenia saurita, which is also striped longitudinally, though with differently arranged colors. Both species are highly aquatic in habit.

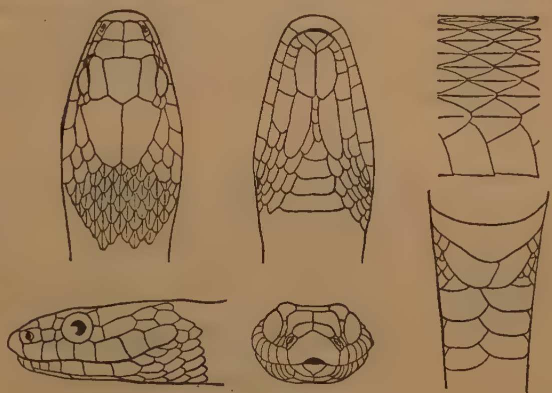


Fig. 15 Natrix leberis

Natrix leberis, though included in many faunal lists, seems to be scarce throughout our region, as nearly every observer states that he has never met it, himself, but includes it on good authority.

Cope (1900, p. 995) notes a specimen (no. 10,729) in the U. S. national museum from Livingston county, N. Y.

15 Natrix kirtlandii (Kennicott)

Kirtland's snake

Jordan. Clonophis kirtlandi

Head very small; not distinct from body. Scales very strongly keeled, in 19 rows.

Above, light reddish to purplish brown, with four rows of large darker blotches on back and sides; beneath, pale brick red, with black spots. Length 16 inches.

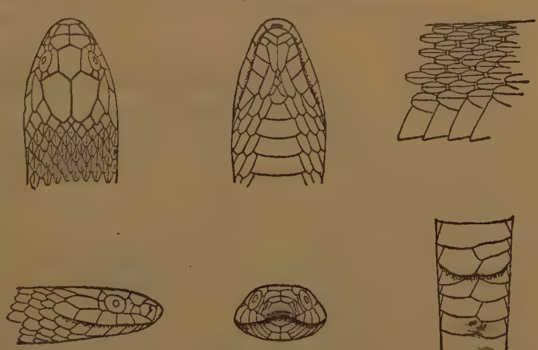


Fig. 16 Natrix kirtlandii

Recorded by Abbott ('68) from New Jersey, but the identification apparently doubted by Nelson ('90). Cope (1900, p. 997) restricts its range to Wisconsin, Michigan, Illinois, Indiana and Ohio.

16 Storeria dekayi (Holbrook)

De Kay's brown snake

De Kay. Tropidonotus dekayi
Jordan. Storeria dekayi

Head distinct from body. Scales keeled, in 17 rows. One preocular.

Fig. 17 Storeria dekayi

Color above, grayish brown to chestnut brown; with a rather faint dorsal band of lighter brown, margined by dark brown or black dots; below, grayish white. Length 12 inches.

Distinguished from Carphophiops amoenus and Storeria occipitomaculata by its gray (instead of reddish) coloration below; and farther from C. amoenus by the distinctness of its head.

"Quite common in rocky portions of Central park." *Ditmars.* '96, p. 21

"Abundant in southeastern New York." *Eckel.* 1901, p. 153

"Occurring, but not common, in Rockland county." *Wallace.* 1901

17 Storeria occipitomaculata (Storer)

Brown snake

Jordan. Storeria occipitomaculata

Head distinct from body. Scales keeled, in 15 rows. Two anteoculars.

Fig. 18 Storeria occipitomaculata

Above, grayish brown to chestnut brown, sometimes with a paler dorsal band; three light colored spots behind head; beneath, salmon pink. Length 15 inches.

"Extralimital; Massachusetts." *De Kay*, p. 41

"Common under stones and leaves." *Mearns*. '98, p. 327

"Common in the Schoharie valley; most often seen after sundown." *Mearns*. '99, p. 345

"Abundant in southeastern New York." *Eckel*. 1901, p. 153

"Fairly common near Ithaca." *Reed*. 1901

"Common in the farming country, but seldom seen in the hills, of Rockland county." *Wallace*. 1901

18 **Eutaenia saurita** (Linn.)

Ribbon snake

De Kay. Leptophis saurita

Jordan. Thamnophis sauritus

Form elongate; slender; scales strongly keeled, in 19 rows; tail one third (or more) of total length of body.

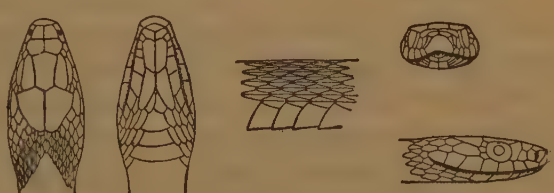


Fig. 19 Eutaenia saurita

Color light brown, with three light yellow stripes which are often margined with black; abdomen greenish white. Length 36 inches. The lateral stripe is on the third and fourth rows of scales, while in Eutaenia sirtalis it occupies the second and third rows.

"Common, especially in fields and meadows through which streams flow and where mice are abundant." *Mearns*. '98, p. 327

"In Westchester and Putnam counties this species appears to be even more abundant than Eutaenia sirtalis." *Eckel*. 1901, p. 154

"Common near Ithaca." *Reed*. 1901

"Frequently found in Rockland county." *Wallace*. 1901

19 Eutaenia brachystoma (Cope)

Head not distinct from neck; superior labials six; inferior labials eight. Scales keeled, in 19 rows. Two distinct nasal plates. Tail one fourth total length.

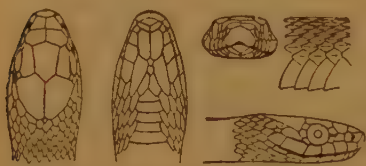


Fig. 20 Eutaenia brachystoma

Color below, light olive, unspotted; above darker olive, with a broad, brown band on each side, extending from the fourth to the middle of the ninth row of scales, inclusive; chin yellowish.

The type specimen, and the only one so far obtained, is stated by Cope (1900, p. 1057) to have come from Franklin, Venango co. Pa.

20 Eutaenia sirtalis (Linn.)

Garter snake

De Kay. Tropidonotus taenia
Jordan. Thamnophis sirtalis

Head distinct, oval; body moderately robust; form in general much stouter than Eutaenia saurita; tail between one quarter and one fifth of total length. Superior labials eight; inferior labials 10; scales keeled, in 19 rows. Color above varying from light green through olivaceous to black, usually traversed by three longitudinal stripes, of which the laterals are not well defined, and all three may be very faint or entirely wanting. Below, usually light bluish green, but varying to darker and even to black.

This, the common "garter snake," is abundant throughout the state, and ranges in altitude from tide level to the highest summits of the Catskills and Adirondacks. It is the most variable of American serpents, no less than six "subspecies" having been recorded from the area here considered. In the author's opinion, however, these six forms are of very unequal systematic value, and calling all of them subspecies merely results in rendering that term meaningless. At some future time the author hopes to be in a position to discuss the New York forms, at least, in more detail; but at present this is impossible, owing to lack of the large series of fresh specimens which such an investigation would require. This being the case, the six "subspecies" noted have been listed and described on the following pages, but the reader may expect to find

specimens of Eutaenia sirtalis agreeing with several of the subspecific descriptions, or differing from all of them.

20a **Eutaenia sirtalis graminea** (Cope)

Green garter snake

Above, light green, with no stripes or spots on upper side of body or head; below yellow, clouded with green. Lips, chin and throat uniform yellow.

Cope (1900, p. 1067) lists specimens from Ohio, Massachusetts and Maine. I have never seen a New York specimen of Eutaenia sirtalis approaching the coloration of this form.

20b **Eutaenia sirtalis ordinata** (Linn.)

Spotted garter snake

Jordan. Thamnophis sirtalis ordinatus

General color greenish brown or olive; stripes faint; three series of small square dark blotches on each side; beneath, greenish white, with spots of black near each end of the gastrosteges; upper labial plates all edged prominently with black.

I have found this "subspecies" at Vernon, Oneida co., Peekskill, Westchester co., Central Valley, Orange co. A specimen is in the museum collection, taken by Dr M. S. Farr at Kenwood, Albany co., and another, less typical, taken by Dr Tarleton Bean at Patchogue, Long Island. Ditmars ('96, p. 20) mentions specimens taken on Long Island, and at Fort Lee N. J.; while Wallace (1901) notes the occurrence of the subspecies in Rockland county.

20c **Eutaenia sirtalis sirtalis** (Linn.)

Striped garter snake

Color above the yellowish lateral stripes dark olive to dark brown; a narrow, rather indistinct greenish yellow vertebral line; three

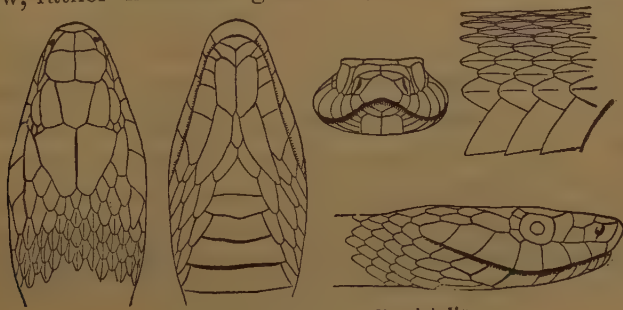


Fig. 21 Eutaenia sirtalis sirtalis

series of small indistinct spots on each side; below, greenish white; black blotches on gastrosteges near outer margins.

Common everywhere throughout the state, though possibly many specimens identified as belonging to this subspecies may have been really one of the three following.

20d **Eutaenia sirtalis obscura** (Cope)

Dusky garter snake

Jordan. Thamnophis sirtalis obscurus

A yellowish dorsal band, with lateral bands less distinct; ground color, exposed between these bands, is uniformly brownish, caused by the complete fusion of the spots shown on other subspecies; below, grayish green, with black spots near ends of gastrosteges.

Specimens noted by Cope (1900) from Westport, Essex co.

20e **Eutaenia sirtalis dorsalis** B. & G.

Red garter snake

Jordan. Thamnophis sirtalis dorsalis

Ground color brownish; lateral stripes olivaceous; dorsal stripe bright red; lateral spots separated by red interspaces.

From descriptions given in many of the faunal lists published for the region under consideration, I am led to believe that many specimens from New England and northern New York are to be classed with the "dorsalis" group, and I have therefore inserted a description of its typical subspecies.

20f **Eutaenia sirtalis pallidula** (Allen)

General color above, olive to olive brown; dorsal stripe, except at its inception, almost obsolete; the interlinear spots of reddish scales with narrow black edgings and black interspaces. Belly, in young specimens grayish white, in adults from grayish white to light yellowish.

The above description is quoted from Allen ('99) where the subspecies is first described, a paper to which readers are referred for a more detailed description. In this paper Mr Allen gives its distribution as "from the White mountains of New Hampshire and the Adirondacks of New York, northward into New Brunswick and Nova Scotia, and possibly farther;" while in a later communication to the author he instances a specimen of this subspecies caught at Chateaugay, Franklin co. N. Y.

The author has not seen the specimens on which this subspecies is based, but from the published description the form seems to be entitled to as much recognition as E. s. graminea, and certain other forms to which Cope has given subspecific rank.

B. CROTALIDAE

Deep pit between eye and nostril; head rather markedly triangular; neck constricted; subcaudals entire. No normal (solid) teeth upon the upper jaw, which carries erectile hollow poison fangs. All the species are venomous.

21 **Ancistrodon contortrix** (Linn.)

Copperhead

De Kay. Trigonocephalus contortrix
Jordan. Agkistrodon contortrix

No rattle. Top of head with nine symmetric plates in front; scales behind. Scales in 23 rows. General form robust.

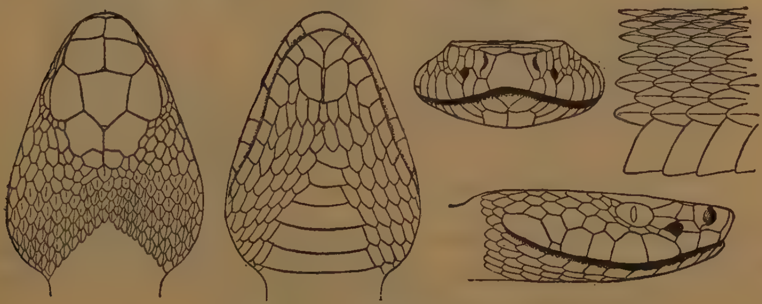


Fig. 22 Ancistrodon contortrix

Above hazel brown, becoming bright copper colored on head; darker chestnut colored blotches on sides; beneath dull yellowish, with a series of distinct, large, dark blotches on each side. Chin and throat unspotted. Sides of head cream color. Length 40 inches.

"Though found in the western part of the state, most numerous in the meadows of Columbia and Dutchess counties." *De Kay*, '42

Ditmars ('96, p. 23) mentions occurrences at Alpine N. J., and in Putnam, Westchester and Dutchess counties, N. Y.

"Much more common than the 'rattler.' Some are killed in hay-fields in the neighborhood of Highland Falls, Orange co. each year." *Mearns.* '98, p. 327

"Occurs in swamps and low grounds in Orange and Dutchess counties, but scarcer in the Highlands." *Eckel.* 1901, p. 154

"Very common in Rockland county." *Wallace.* 1901

The milk snake (p. 374); the water snake (p. 377) and the blowing adder (p. 368) are frequently confounded with this species, though bearing only a very superficial resemblance to it.

22 Sistrurus catenatus catenatus (Rafinesque)

Massasauga

Gebhard. '53, p. 22. Crotalophorus tergeminus

Jordan. Sistrurus catenatus

Tail with a rattle. Head with nine symmetric plates in front; covered with scales behind. Scales in 25 rows. Urosteges undivided, except the last three to five, which are bifid.

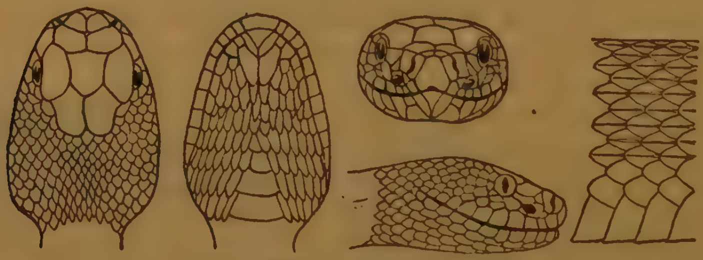


Fig. 23 Sistrurus catenatus catenatus

Ground color above, brown; blotches deep brown to blackish, with yellowish white margin; color beneath, blackish brown, intermingled with yellowish. Length 24–30 inches.

The rattles of this species are much smaller than those of a banded rattlesnake of equal length; and their sound is correspondingly feeble.

Described by De Kay ('42, p. 57) as extralimital, this species was added to the New York faunal list by Gebhard ('53, p. 22), a specimen having been sent in by the Hon. Levi Fish, from the town of Byron, Genesee co. Gebhard states further that in this town "their habitat is a white cedar swamp, containing an area of about one thousand acres. During the summer season, they leave the swamp, and go into the adjoining fields of grain, where they remain until fall, when they return to the swamp and hibernate." No later record exists of their occurrence in New York state; and

the species has never been noted from any of the other states falling within the scope of this paper. It occurs, however, in Ohio (W. H. Smith, '82, p. 672), from which state it is also listed by Cope (1900, p. 1149) and Morse (1901).

It seems highly probable that many of the western New York localities given by Macauley ('29) for the rattlesnake may, in reality, refer to this species.

23 Crotalus horridus Linn.

Banded rattlesnake

De Kay. Crotalus durissus
Jordan. Crotalus horridus

Tail with a rattle. Top of head covered entirely with scales. Scales in 29 rows.

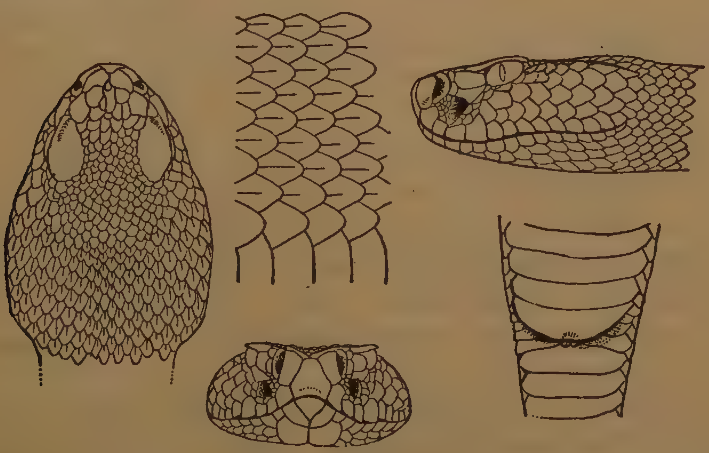


Fig. 24 Crotalus horridus

Color above, bright yellowish to dark brown; two series of dark brown to black spots on each side of median line, often confluent across back; tail black; below, yellowish white to gray. Length 60 inches.

Macauley ('29, p. 514) gives an interesting and detailed account of the distribution, at that date, of the rattlesnake.

"They are found on Long Island and Manhattan Island; in some parts of the Highlands; around the head of Lake Champlain; at and around Lake George; at Glenville, in the county of Schenectady; at the Noses, in the county of Montgomery; along some parts

of Unadilla and Susquehanna rivers; at Lenox and Sullivan, in the county of Madison; at Manlius and Onondaga, in Onondaga county; in some parts of the county of Ontario; along Genesee and Niagara rivers; and in many places in the Oak lands, between those rivers, and also east of the former; at several places along the Schoharie creek; at the Helderberg, in the county of Albany; at Snake hill, near Newburg; and in some other places."

De Kay ('42), says of the species:

"It is common in various parts of the state, and in the northern states generally appears to prefer rocky situations. They abound in Clinton, Essex and Warren counties, along the shores of Lakes Champlain and George. Although numerous in the rocky mountainous districts of this state, they are rare or entirely wanting in those elevated regions which give rise to the Moose, the Racquette and the Hudson rivers. They are found in the counties of Sullivan, Ulster, Orange and Greene. A few still linger in the swamps of Suffolk county."

"Becoming quite rare within 50 miles of New York city, the nearest locality in which it has been found in the past few years being Putnam county, N. Y.; it also occurs in Connecticut, and Prof. E. B. Southwick tells me that a few are found annually in the central part of Long Island." *Ditmars.* '96, p. 24

"Formerly numerous about Highland Falls; now extremely rare." *Mearns.* '98, p. 327

"Still occurs in Orange and Rockland counties, but very rare and possibly extinct east of the Hudson in this state. Cope notes a specimen collected in 1878 at Katonah, Westchester co.; and I have been informed that one was killed in 1887 near White Plains N. Y." *Eckel.* 1901, p. 155

"Still met with in Rockland county." *Wallace.* 1901

Rattlesnakes are occasionally reported from the western counties of this state. It is possible that some of these accounts may refer to the massasauga (p. 386) whose present distribution in the state is unknown.

LIZARDS, TORTOISES AND BATRACHIANS OF NEW YORK

BY F. C. PAULMIER PH. D.

INTRODUCTION

The following catalogue describes the lizards, tortoises and batrachians which occur in New York or which from their occurrence in adjoining states may be expected to be found here. Since the appearance of Holbrook's and DeKay's work, no papers dealing with these forms as a whole, have appeared, except those of Sherwood and Smith which catalogue the species found near New York city. Thus practically nothing is known of the forms found in the northern and western part of the state and collections made there would be of great value in studying the distribution of the groups.

The main works on the lizards, tortoises and batrachians are included in the following bibliography. Other references will be found in the list on p. 357, where such works are marked with an asterisk. The descriptions are taken mainly from the papers by Cope and Jordan.

Cope, E. D. '89. The batrachia of North America. U. S. nat. mus. Bul. 34. 1889.

——— '98. Crocodilians, lizards and snakes of North America. U. S. nat. mus. Rep't. 1898.

Jordan, D. S. '99. A manual of the vertebrate animals of the northern United States. Ed. 8. 1899.

DeKay, J. E. '42. Natural history of New York. Zoology of New York. v. 3. Reptiles and amphibia. 3, text; 4, plates. 1842.

Holbrook, J. E. '42. North American herpetology. 1842.

Sherwood, W. L. '94. Salamanders found in the vicinity of New York city, with notes on extralimital or allied species. Linn. soc. of N. Y. Abst. proc. 1894–95. No. 7.

——— '97. Frogs and toads found in the vicinity of New York city. Ibid. 1897–98. No. 10.

Smith, Eugene. '98. Turtles and lizards of the vicinity of New York city. Ibid. 1898–99. No. 11.

A. LACERTILIA

Lizards

Long-tailed reptiles, covered with scales; usually with four limbs terminating in claws. The young undergo no metamorphosis, being hatched from the egg in a form resembling the parent. Lizards prefer warm climates and but three species are found within our limits, two being fairly common, while the other is recorded only once from this state.

1 **Sceloporus undulatus** Latreille

Common lizard, swift, fence lizard, pine lizard

De Kay[1]. Tropidolepis undulatus, the brown swift, p. 31, pl. 8, fig. 16

Brownish olive or gray, with black, wavy, V shaped bands on each side; throat and sides of belly in male, blue with a black edging. Length 7 inches.

Its eggs, which are long and narrow, are laid in the sand about June 1 and hatched about July 10.

Found in southern part of the state. Very rapid in its movements, and frequently found under bark of decayed trees. It chooses old fences as its basking places.

2 **Eumeces quinquelineatus** Linn.

Blue-tailed lizard

De Kay. Scincus fasciatus, blue-tailed lizard, "scorpion," p. 29, pl. 8, fig. 17

Color variable, but usually olive with five yellowish streaks, the middle one forking on the head; tail bright blue. Old specimens become reddish and stripes grow fainter and may disappear. Length 8–11 inches.

Found in the southern part of the state; lives on the ground; is very active; it readily parts with a portion of its tail when an attempt is made to capture it.

3 **Liolepisma laterale** Say

Ground lizard

Upper parts of head and body reddish olive; on each side a black stripe; the sides below this lateral band striped alternately dusky

---

[1] References to De Kay under the different species refer to the *Zoology of New York, Reptiles and amphibia*, v. 3, text; v. 4, plates, by James E. De Kay, 1842.

and lighter; abdomen yellowish; tail pale bluish or greenish below. Length 5 inches.

Usually considered a southern form; but Cope notes a specimen taken in Burlington county, N. J.; and H. D. Reed informs me that a specimen in the collection of Cornell university was captured Ap. 23, 1892, on the Caroline hills, southeast of Utica N. Y. by W. J. Terry.

B. CHELONIA

Turtles

The turtles and tortoises, which comprise the order Chelonia, may be defined as reptiles having the skeleton mainly external. The body is inclosed in a shell of bony plates consisting of a dorsal carapace (to which the vertebrae and ribs are firmly fused) and a ventral plate or plastron. Both of these are covered over with horny plates which are composed of the well known tortoise shell.[1]

The vertebrae of the neck and tail are free and movable. The limbs are well developed and usually terminated by claws. In some forms there is a web between the toes, while in the marine forms (not included in this list) the feet have the form of flippers. Teeth are never developed, the jaws being covered by a layer of horn.

Their eggs, which have a tough leathery shell, are laid in the dry sand and are hatched by the heat of the sun. Like all reptiles, the young leave the egg in the form of the parent, and thus do not undergo any metamorphosis, as do the batrachians. They breathe by lungs throughout their entire existence.

The Chelonia are found both on land and in water, many forms being apparently equally at home in either.

Omitting the marine turtles, our forms represent four families.

1 Trionychidae, soft-shelled turtles
2 Chelydridae, snapping turtles
3 Kinosternidae, box or musk turtles
4 Emydidae, pond turtles

Family 1 TRIONYCHIDAE
Soft-shelled turtles

Body flat, round; carapace not completely ossified, and with the

[1] The tortoise shell of commerce is derived from one of the marine forms.

plastron covered by a thick leathery skin, flexible at the margins; neck long and flexible, snout pointed and tubular; feet webbed. Aquatic, carnivorous and very voracious.

1 Amyda mutica Le Sueur

Leather turtle

A depression along median line of carapace, no spines or tubercles; olive to brown, young spotted; feet not mottled below. Length 12 inches.

Probably found in the northern part of the state in Lakes Erie and Ontario and the streams flowing into them.

2 Aspidonectes spinifer Le Sueur

Soft-shelled turtle

De Kay. Trionyx ferox, p. 6, pl. 6, fig. 11

Carapace slate-colored with spots; legs and feet mottled everywhere with dark; anterior part of carapace with tubercules.

Found in Lakes Ontario and Erie, from which they come through the Erie canal to the Hudson; also in southwestern part of state.

Family 2 CHELYDRIDAE

Snapping turtles

Represented by one species with the characters of the family.

3 Chelydra serpentina L.

Snapping turtle

De Kay. Chelonura serpentina, p. 8, pl. 3, fig. 6

Young dusky brown with dark spots; head very large; jaws strong; tail long and strong, with crest of compressed tubercles; plastron small, cross-shaped, leaving the body largely uncovered; toes partially webbed. Length 24 inches.

Found all over the state in quiet waters. Its snapping propensities are well known. In the spring it lays 60 to 70 eggs in the sand, frequently at some distance from the water (De Kay).

Family 3 KINOSTERNIDAE

Box turtles

Carapace long and narrow, lightest behind; margins turned downward and inward rather than outward; plastron large; head pointed; limbs slender.

4 Kinosternun pennsylvanicum Bosc

Mud tortoise

De Kay. K. pennsylvanicum, p. 21, pl. 2, fig. 4

Shell dusky brown; head dark, with light dots. Differs from the following species in that the plastron is divided into two parts, so that the animal can shut itself up almost completely. Length 4 inches.

Rare but may be taken in southern part of the state. Frequently found on land.

5 Aramochelys odorata Latreille

Musk turtle, stink pot

De Kay. Sternothaerus odoratus, p. 22, pl. 7, fig. 13

Shell dusky, sometimes spotted, usually covered with mud and green algae; neck with two yellow stripes; plastron cross-shaped, somewhat like Chelydra but larger; head large, jaws strong, odor strong musky.

Found in ponds and ditches all over the state. Is a nuisance to fishermen, whose hooks it takes.

Family 4 EMYDIDAE

Pond turtles

Carapace ovate, broadest behind, the margins having a tendency to flare outward; plastron covering entire ventral surface, its plates 12 in number.

6 Graptemys geographicus Le Sueur

Map turtle

De Kay. Emys geographica, The geographic tortoise, p. 18, pl. 4, fig. 7

Dark olive brown with network of greenish or yellow lines, more prominent on edges of carapace; head and neck also with yellow stripes; plastron yellowish; carapace notched behind and keeled.

Found in streams in western part of state.

7 Graptemys pseudogeographicus Holbrook

De Kay. Emys pseudogeographicus, the pseudo-geographic tortoise, p. 19, pl. 2, fig. 3

Much like preceding but browner, the markings on the shell pale and in larger pattern; keel of carapace stronger, back of each plate in the middle line projects over succeeding one; plastron yellowish, marbled with reddish brown; head and legs with bright yellow stripes.

Said by De Kay to have been taken in Lake Erie. A western form.

8 **Malaclemmys centrata** Labr.

Salt marsh turtle, diamond back

De Kay. Emys palustris, the salt water terrapin, p. 10, pl. 3, fig. 5

Greenish or dark olive, plates of both shells usually with concentric dark stripes, sometimes grooved. Length 10 inches.

Occasionally found along the coast; the only one of our turtles except the true marine forms, which is found in salt water.

9 **Pseudemys rubriventris** Le Conte

Red-bellied terrapin, slider

De Kay. Emys rubriventris, p. 16, pl. 7. fig. 14

Dusky or blackish with irregular red markings, specially on edge of shell; plastron red and yellowish with dark spots; head and neck brown with reddish and yellowish lines.

In streams in the southeastern part of the state. Used as a substitute for the real terrapin.

10 **Pseudemys hieroglyphica** Holbrook

Shell depressed, olive brown, marked with groups of concentric yellowish lines; plastron yellowish; head very small with yellow lines.

A southwestern form, habitat given by Jordan as New York to Wisconsin and south.

11 **Chrysemys picta** Herm.

Painted turtle, mud turtle

De Kay. Emys picta, p. 12, pl. 5, fig. 10

Greenish black, plates edged with yellow; the marginal plates marked with bright red; plastron yellow with brown blotches; legs and tail with red lines; upper jaw notched in front. Length 6 to 8 inches.

Very common throughout the state, preferring quiet waters and frequently seen basking in the sun, on logs.

12 **Chrysemys marginata** Agassiz

Colors similar to preceding, but plates of carapace alternating; the lateral rows out of line with the middle one, instead of forming three sets of three as in above; lateral plates with strong concentric grooves. Possibly a form of the preceding.

Found in the western part of the state.

13 Chelopus muhlenbergii Schw.

Muhlenberg's tortoise

De Kay. Emys muhlenbergii, Muhlenberg's tortoise, p. 17, pl. 8, fig. 15

Brown with yellowish markings; plastron black with yellowish blotches; an orange spot on each side of the neck; plates of back plain or concentrically grooved. Length 4½ inches.

Southern part of state, particularly in the branches of the Delaware river.

14 Chelopus insculptus Le Conte

Wood tortoise

De Kay. Emys insculptus, wood terrapin, p. 14, pl. 4, fig. 8

Carapace with a keel, its plates marked with concentric striae and radiating black lines; ground color yellowish or reddish brown; plastron with a black blotch on each plate. Length 8 inches.

All over the state, taken both in land and water.

15 Chelopus guttatus Schnei.

Speckled tortoise

De Kay. Emys guttata, the spotted tortoise, p. 13, pl. 16, fig. 12

Black with yellow spots, whose number varies with age, the young having only a single spot on each plate; plastron yellow, blotched with black. Length 4½ inches.

Common in ponds all over the state, frequently seen sitting on logs.

16 Emydoidea blandingii Holbrook

Blanding's tortoise

De Kay. Cistudo blandingii, p. 25, pl. 1, fig. 2

Black with numerous round or oblong yellow spots; plastron with a transverse hinge, as in the common land tortoise, enabling the animal to shut itself up tightly. Young jet black without spots.

Rare but possibly to be taken in this state.

In habits similar to following.

17 Cistudo carolina L.

Box tortoise

De Kay. C. carolina, box turtle, p. 24, pl. 21, fig. 1

Colors highly variable, usually yellowish brown with spots and blotches of yellow; plastron with a hinge, as in preceding. Length 5–7 inches.

Found all over the state in dry places.

BATRACHIA

Batrachians, or amphibians, are vertebrates with soft skins, which possess gills, either during their earlier or larval stages only or throughout life, and which usually breathe by lungs in the adult.

The living representatives of the group are divided into three orders: 1) Proteïda, which retain their gills throughout life, and of which our only representative is the mud puppy, Necturus; 2) Urodela, long-tailed forms which lose their gills in the adult stage and include the salamanders and newts;[1] and 3) (Anura) Salientia, tailless forms, without gills in the adult and with hind legs adapted for leaping, and including the frogs and toads.

The adult batrachians are found mostly in moist places, their soft skins generally unfitting them for the hot, dry places which many of the reptiles are so fond of. Thus the greater number of forms are found in or near water (frogs and some salamanders) or under stones and logs in woods (most salamanders). A few, such as the tree frogs are arboreal; others, including some of the salamanders and the wood frog, are found on the ground in dry woods; while the common toad is found everywhere on land.

In the spring, however, almost all forms seek the water to breed. Their eggs are the round black bodies contained in the transparent jellylike masses which are so frequently found in ponds. These give rise to the well known limbless tadpoles, or polliwogs, which possess gills and are thus fitted for a subaquatic, fishlike existence. After a shorter or longer period, the limbs appear and lungs develop, while the gills disappear (in most cases), so that the animal becomes an air-breathing, instead of water-breathing form.

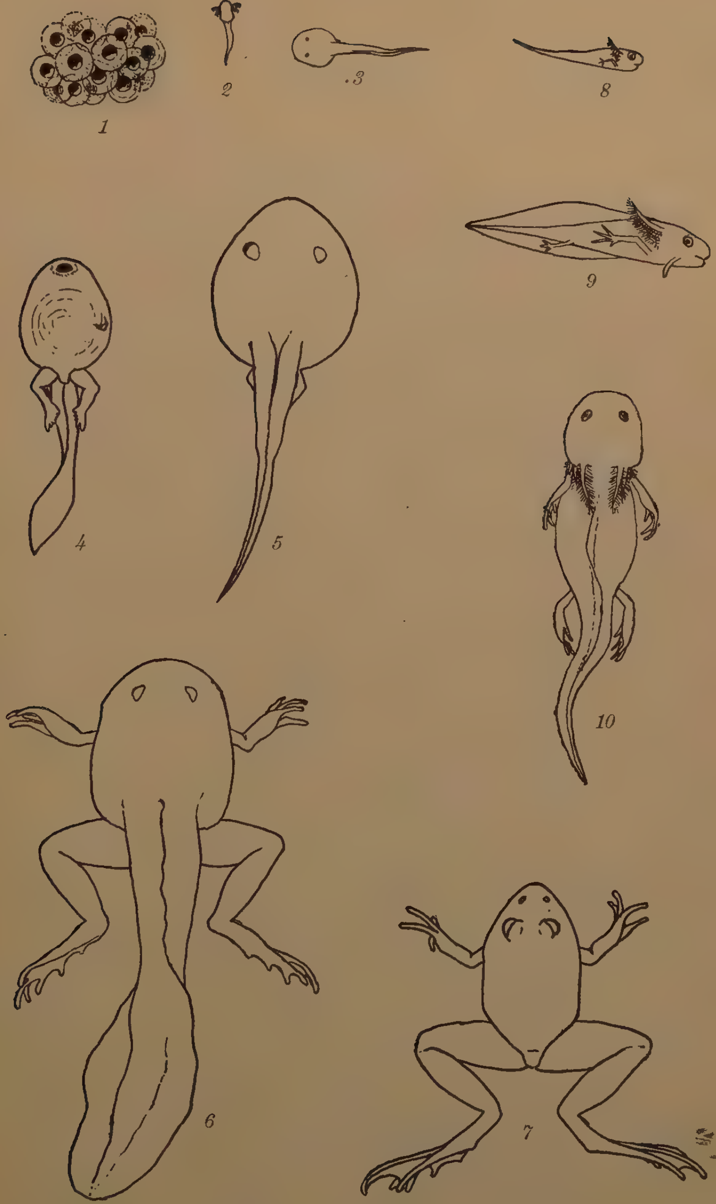
The batrachians are all perfectly harmless forms and, with very few exceptions, never even attempt self-defense. For their protection from enemies they rely on their coloration and on their places of concealment.

Their food consists almost entirely of insects, so that they have a distinct economic value.

---

[1] There is no common American term for these forms, though the word lizard is occasionally employed. This is a misnomer, as the lizards are reptiles, which, while they resemble the batrachians in form, have a scaly skin and never have gills.

Plate 1.



Metamorphoses of Batrachia

Fig. 1-7 Development of frog

Fig. 8-10 Stages in development of salamander

Order 1 PROTEÏDA

Large eellike forms, which retain their external gills throughout life. Lungs are developed, but are not normally functional. Only one family.

Family PROTEIDAE

Represented here by one species.

1 **Necturus maculatus** Rafinesque

Mud puppy

De Kay. Menobranchus lateralis, The banded proteus, p. 87, pl. 18, fig. 45.

Much the largest of our batrachians, except the hellbender, reaching a length of 2 feet. Eellike, with feeble legs; light chocolate brown, with darker brown spots. Three pairs of bushy, bright red, external gills.

Common in most of the larger streams and lakes of the northern and western part of the state. Found in the Erie canal. De Kay ('42) stated that it would soon be found in the Hudson river, a prediction since verified, as numerous specimens are now taken around Albany. Information as to how far up and down the river it has reached is greatly to be desired.

Order 2 URODELA

Salamanders

Include all the rest of the long-tailed batrachians. No gills in the adult stage; limbs equally developed. The eggs are usually laid in the water either singly on leaves or in masses like those of the frog. The larvae or tadpoles differ from those of the frogs and toads in that the gills are not covered over, but remain external and do not disappear till a late stage. A pair of processes known as balancers occurs in front of the gills. Three stages in their development are shown in fig. 8–10 of pl. 1.

The following families are represented within our limits.

1 Cryptobranchidae
2 Amblystomidae
3 Plethodontidae
4 Desmognathidae
5 Pleurodelidae

Family 1 CRYPTOBRANCHIDAE

Giant salamanders

Represented by one species with the characters of the family.

2 **Cryptobranchus allegheniensis** Daudin

Hellbender

De Kay. Menopoma alleghaniensis, the Alleghany hellbender, p. 89, pl. 18, fig. 44

A large form, reaching at times, 2 feet. Generally lead-colored, occasionally spotted; head broad and flat; body with a lateral fold of skin. A very unprepossessing but harmless creature. Nothing is known of its breeding habits.

Probably found in the branches of the Alleghany river in the western part of the state. Where it is common, it annoys fishermen by taking their hooks. It is remarkably tenacious of life.

Family 2 AMBLYSTOMIDAE

Blunt-nosed salamanders

Except for the two preceding forms the members of this family are the largest and stoutest of our salamanders. They are almost entirely land forms, except in the breeding season, the spring, when they migrate to the ponds to lay their eggs. These are somewhat larger and fewer than frogs eggs, and the jellylike mass surrounding them is whiter and more opaque.

3 **Amblystoma opacum** Gravenhorst

De Kay. Salamandra fasciata, the blotched salamander, p. 77, pl. 17, fig. 40

Black above, with about 14 bluish gray bars running across; belly dark blue. 11 costal grooves between legs. Length 3½ inches; very stout.

Southern part of state. This species is found in dryer places than the majority of salamanders, even on bare rocks in the sun (Mearns) and in sandy places (Cope).

4 Amblystoma punctatum Linn.

Spotted salamander

De Kay. Salamandra subviolacea, large spotted salamander, crimson spotted triton, p. 74, pl. 16, fig. 36

Black above, with a series of round yellow spots on each side of the back; body broad, depressed, and swollen; tail not as long as rest of body. 11 costal grooves on each side. Length 6½ inches.

Probably generally distributed over the state. Found under rocks and decaying trees, and occasionally wanders into cellars.

5 Amblystoma conspersum Cope

Smaller spotted salamander

Lead-colored, with one or two series of small yellowish spots along sides; skin smooth; body more slender than the preceding; tail shorter than head and body. 11 costal grooves. Length about 4 inches.

Taken in Pennsylvania, and may be found in southern part of this state.

6 Amblystoma tigrinum Green

De Kay. Triton tigrinus, tiger salamander, or triton, p. 83, pl. 15, fig. 32

Dark brown, with usually, many irregular yellow blotches, sometimes arranged in cross bands; body thick and strong; head long; tail about equal in length to body. 12 costal grooves. Length 8–10 inches. The largest of our salamanders and very variable.

All over the state. Said by De Kay to be found in decayed, hollow trees, but usually in burrows and under stones.

7 Amblystoma jeffersonianum Green

De Kay. Salamandra granulata, the granulated salamander, p. 78, pl. 23, fig. 66; Triton niger, the dusky triton, p. 85, pl. 15, fig. 35

Olive-brown or blackish, usually with bluish spots, but sometimes uniformly lead-colored; head small; eyes far back; body slender. 12 costal furrows. Length 5–8 inches.

Two varieties, possibly throughout the state. According to De Kay, inhabiting wet, springy places.

The three following families of Urodela, while possessing well marked osteologic differences, show no external characters sufficiently obvious to distinguish them easily. For this reason no description has been attempted.

Family 3 PLETHODONTIDAE

8 **Hemidactylium scutatum** Schlegel

Four-toed salamander

Brown above; snout yellow; whitish below with dots like ink spots; skin finely granulated, resembling scales. Somewhat resembles Plethodon cinereus, but has only four toes on each foot. 14 costal furrows. Length 2½ inches.

Probably to be found in this state.

"Under logs and rails in open woods at some distance from water." *W. H. Smith.* '82

9 **Plethodon cinereus** Green

De Kay. Salamandra erythronota, the red-backed salamander, p. 75, pl. 16, fig. 38

Three subspecies of this form are distinguished by Cope.

a Plethodon cinereus cinereus, color, liver-brown, below dirty white mottled with black, giving a "pepper and salt" appearance, sometimes yellowish toward the head. 18 costal grooves.

b P. c. erythronotus. Form and structure similar to above but back with a broad, reddish stripe. 18 costal grooves. Resembles Spelerpes bilineatus, but in that form the belly is unspotted and there are fewer costal furrows.

c P. c. dorsalis. Quite similar to c. erythronotus but with only 16 costal furrows. Much rarer than the others.

All these subspecies are entirely terrestrial and found under stones and logs in woods. Eggs laid in a little package under stones in damp places. The young possess gills when hatched, but very soon lose them. The most abundant salamander, found everywhere, specially in the mountains.

10 **Plethodon glutinosus** Green

De Kay. Salamandra glutinosa, the blue-spotted salamander, p. 81, pl. 17, fig. 42

Skin covered with a milky secretion. Black, usually with bluish white blotches and specks; head, body and tail continuous and rounded. Much like Amblystoma jeffersonianum, but has lighter spots and shorter digits. 14 costal furrows. Length 5–7 inches.

Entirely terrestrial and found in the mountains, where it prefers the coolest spots. Both in rocky localities and in forest mold and fallen logs.

11 Gyrinophilus porphyriticus Green

De Kay. Salamandra salmonea, salmon-colored salamander, p. 75, pl. 16, fig. 39

Yellow or purplish brown or salmon-colored, irregularly blotched with gray, white below, tail rounded at base. 16 costal furrows. Length 6 inches.

An aquatic mountain form, preferring cool mountain springs and swamps to streams.

"This is the only one of our eastern salamanders that attempts defense. It snaps fiercely but harmlessly and throws its body into contortions." *Cope*

12 Spelerpes bilineatus Green

De Kay. Salamandra bilineata, the striped-back salamander, p. 77, pl. 23, fig. 67

Yellow; back with a tinge of brown which is bordered by a darker brown line; belly yellow, unspotted; tail slender and compressed, longer than rest of animal. 14 costal grooves between the limbs. Length 3 inches.

Occurs all over the state; in shallow, stony brooks, but occasionally found under stones or bark. Very active and behaves like Desmognathus fusca, with which it is frequently found.

13 Spelerpes longicauda Green

Cave salamander

De Kay. Salamandra longicauda, long-tailed salamander, p. 78, pl. 17, fig. 41

Bright lemon yellow, back and sides covered with black specks running into bands on the tail; belly unspotted; tail one and one half times as long as body and very compressed. 12 costal grooves. Length 5 inches.

Found in rocky ground and in fissures and caves. Said by De Kay ('42) and W. H. Smith ('82) to be aquatic. Probably rare.

14 Spelerpes ruber Daudin

De Kay. Salamandra rubra, red salamander, p. 80, pl. 17, fig. 43

Orange red, with numerous crowded dark spots; between these is a clouding of dark red brown; under surface with very small black

dots. Almost as stout as Amblystoma punctatum, but no neck; head passing into body, which is of the same diameter throughout and passes insensibly into the square tail, which narrows toward tip. 15 costal furrows. Length 6 inches.

Generally aquatic, preferring cold springs, and is found on the ground only after rains. Occasionally found under bark of fallen trees in very damp places.

Family 4 DESMOGNATHIDAE

15 **Desmognathus ochrophaea** Baird

Alleghany mountain salamander

Brownish yellow with brown shade on each side; a yellowish dorsal band with few spots; belly unspotted. 13 costal furrows. Length 3 inches. Very like Spelerpes bilineatus, but has a more rounded tail, a paler abdomen, and a light bar from eye to mouth. Its habitat is also quite different.

Found in the Adirondacks and Catskills, under bark and decaying trees; not aquatic.

16 **Desmognathus fusca** Rafinesque

De Kay. Salamandra picta, dusky salamander, p. 75

Very variable in color, but usually brown above with gray or purplish spots becoming blackish with age; marbled below; eyes prominent; tail as long as head and body. 15 costal grooves. Length 4–5 inches.

This species makes a curious disposition of its eggs, one of the sexes wrapping the albuminous egg string around the body and remaining concealed in a comparatively dry spot till the eggs hatch.

One of the commonest salamanders; found in rapid and shallow streams under stones.

17 **Desmognathus nigra** Green

Uniform black, with a very stout body, the stoutest in fact of our salamanders. 12 costal grooves. Length 6–7 inches.

Found in Pennsylvania and may be taken in southern part of state in the mountains. Habits like those of D. fusca; found under the stones in cold springs and streams in the mountains; very agile and not easily caught.

Family 5 PLEURODELIDAE

Newts

18 **Diemictylus viridescens,** Rafinesque

Newt, eft

De Kay. Triton millepunctatus, crimson spotted triton, newt, p. 84, pl. 15, fig. 33, 34.

Brownish olive above; straw-colored or dirty white below; each side with a row of three to six scarlet spots, each with a dark border; very small dots all over. 12 obscure costal furrows. Length 3½ inches.

Very common in ponds everywhere. The only one of our salamanders which swims around in deep water and does not live on the bottom or under stones. Eggs laid one at a time in the axils of leaves of water plants.

Var. **miniatus**

Red eft

De Kay. Salamandra coccinea, the scarlet salamander, p. 81, pl. 21, fig. 54 b

Very similar, but bright vermilion red; skin rougher. It is found in the same region but away from water; under stones, etc. coming out after rain. Probably a form of the preceding, its peculiarities being due to life out of water.

Order 3 (ANURA) SALIENTIA

Tailless batrachians

Body short and broad; all four limbs present, the hinder limbs long and strong, adapted for leaping; lower jaw usually toothless; tail wanting in the adult.

The eggs are laid in compact gelatinous masses, usually attached to sticks or weeds, in the water. The young tadpoles have external gills when first hatched, but these are soon covered over by a gill cover, which has a single opening at one side (fig. 4). Both pairs of limbs develop at the same time, but the anterior pair are inclosed in the gill covers and do not break them till a late stage. The tail gradually becomes absorbed, and the gills disappear, while lungs develop, and the animal attains its adult form, which is always frog-like and air-breathing.

Four families: 1 Bufonidae, toads
2 Pelobatidae, burrowing toads
3 Hylidae, tree frogs
4 Ranidae, frogs

Family 1 BUFONIDAE

Represented by one species.

19 **Bufo lentiginosus** (Shaw)

Common toad

De Kay. Bufo americanus, p. 67, pl. 19, fig. 46 (young); pl. 20, fig. 52 (adult)

Yellowish brown with a yellow vertebral line and some brownish spots, but variable; adults very warty; young smooth.

Common everywhere. Their eggs are laid in the spring and are inclosed in a long, thin-walled tube of transparent albumen, which lies in strings on the bottom of the ponds where they are laid. The young attain the adult form at a very much earlier period of their life than the frogs.

Family 2 PELOBATIDAE

Burrowing toads

Represented by one species.

20 **Scaphiopus holbrookii** Harlan

Spadefoot

De Kay. Scaphiopus solitarius, the hermit spade foot, p. 66, pl. 19, fig. 47

Olive brown, a yellowish band on each side from eye to coccyx; a horny, spadelike process on each side of hind foot. Widely distributed, but rarely seen. It remains in burrows which it digs in the earth and lays its eggs in temporary ponds which are formed by rain. Metamorphosis may be very rapid.

Reported by De Kay from Rockland county.

Family 3 HYLIDAE

Tree frogs

Small forms, generally inhabiting trees or bushes and frequently possessing the power of adapting their color to the color of the object on which they rest. Generally with the tips of their toes expanded to form disks. Eggs laid in water, in smaller packages than those of the true frogs.

21 **Chorophilus triseriatus** Wied.

Light, ash colored, with about six dark stripes running back from head; legs blotched; toes without disks Length 1 inch. Found in southern part of state.

22 **Acris gryllus** Le Conte

Cricket frog

De Kay. Hylodes gryllus, the cricket Hylodes, p. 70, pl. 22, fig. 61

Hind legs very long; brown or gray above, with a blackish triangle between eyes; borders of this are green and are continued as a band to the end of the body; sides with three oblique bands; has considerable power of changing its color; ends of toes not expanded. Length 1½ inches.

Found in southern part of state. Frequents the muddy borders of the water, into which it leaps when alarmed. A very strong leaper and is never found on trees.

23 **Hyla pickeringii** Storer

"*Peeper*"

De Kay. Hylodes pickeringi, Pickering's tree toad, p. 69, pl. 20, fig. 51

Yellowish or reddish brown with a darker X-shaped mark in middle of back, extending in front to eyes and to the sides of the body; below, yellowish white; legs barred transversely; large disks on toes. Length 1 inch.

Probably all over the state. Found in colder upland swamps and meadows in the breeding season. Later, tree toads may be found in low places or on the ground in the woods. Later still, they climb the trees, and their voices are almost the last sound heard in the fall.

24 **Hyla versicolor** Le Conte

De Kay. Hyla versicolor, the northern tree toad, p. 71, pl. 21, fig. 53a

Green, gray or brown, varying considerably, as its name indicates, with the color of the object on which it rests; V-shaped black blotches on the back; below, white; behind, yellow; skin, warty; large disks. Length 2 inches.

The tree frog par excellence of our state; found on trees and fences; lays its eggs in small packages on blades of grass in the water.

Family 4 RANIDAE

Frogs

Usually fair sized forms; strongly developed hind legs; hind feet well webbed and no disks on toes; mostly water-inhabiting forms.

25 **Rana virescens** Kalm

De Kay. Rana halecina, the shad frog, common frog, leopard frog, p. 63, pl. 20, fig. 49

Green, with irregular black blotches edged with white; these mostly in two irregular rows on back; legs barred above; belly pale; head rather long. Length 2¾ inches.

Probably the commonest of the frogs; found in moist places and marshes. The first species heard in the spring along with Acris gryllus. Frequently lives in swarms.

26 **Rana palustris** Le Conte

Pickerel frog

De Kay. Rana palustris, p. 62, pl. 22, fig. 60

Light brown with two rows of large, oblong square blotches of dark brown on back, one or two on sides; a brown spot above eye; dark band from nostril to eye; upper jaw white spotted with black. Length 3 inches.

Very widely distributed, from mountains in north of state to salt marshes on coast. Usually found in cold springs and streams, and is seen more frequently than any other frog in the grass.

27 **Rana septentrionalis** Baird

Northern frog

Brown or olive, with paler, wormlike markings over the back and legs; sometimes a few dark blotches behind. Length 2½ inches.

Reported from northern part of the state. An entirely aquatic species.

28 **Rana clamata** Daudin

De Kay. Rana fontinalis, the spring frog, p. 62, pl. 21, fig. 54a

Greenish or brownish, shading anteriorly to a bright green; rounded brown spots all over the back; beneath, grayish white; legs with several transverse bands. Length 3 inches.

Aquatic, haunting all kinds of waters; lives singly or in pairs.

29 Rana catesbiana Shaw

Bullfrog

De Kay. Rana pipiens, p. 60, pl. 19, fig. 48

Greenish of varying shades, with small, faint dark spots above; head usually bright green; lower side silvery white with pale blotches instead of pure white as in R. clamata. Length 5–8 inches.

The largest of our frogs. Found in larger ponds and streams, specially where there is underbrush.

30 Rana sylvatica Le Conte

De Kay. Rana sylvatica, the wood frog, p. 64, pl. 21, fig. 54 (adult); pl. 20, fig. 50 (young)

Pale reddish brown; arms and legs barred above; head small, pointed; dark brown band from eye to arm. Femur and tibia about equal and considerably more than half length of body. Length 1½ inches.

Common in woods. In the highlands of the Hudson it appears about the end of March and lays its eggs in ponds and ditches; then very noisy. Later, in May, it becomes quiet (Mearns).

31 Rana cantabrigensis Baird

"Very similar to preceding, but tibia equals one half length of body; a narrow pale line along thighs behind; a dorsal line from snout to arms; back sometimes with dark spots; no outer metatarsal tubercle."

Habits similar to preceding. Probably in northern part of state.

COLLECTING AND PREPARING

Probably the best way to collect reptiles and batrachians is by shooting them with small shot cartridges in a small rifle or pistol. A shotgun with an "auxiliary barrel" may also be used.[1] Many specimens may be taken by a quick grab with the fingers, but this is not always an agreeable experience for most people. For the Urodela a dip net is very useful, and usually frogs may be taken in that way. For snakes a slip noose of fine wire tied to the end of

[1] These directions are taken almost entirely from the *Directions for collecting reptiles and batrachians* by Leonhard Stejneger, U. S. nat. mus. Bul. 39.

a stick may be used, or a forked stick with which to pin the animal to the ground.

If not dead when taken, specimens may be killed by dropping into alcohol. Snakes may be killed by taking them by the end of the tail and giving them a quick snap which will dislocate the vertebrae.

The prepared specimens will keep better if the alcohol is injected into the body cavity with a hypodermic syringe. If this is not at hand, they may be slit open along the ventral side with a sharp-pointed pair of scissors. In the case of snakes, short slits should be made at intervals. It is well to keep the mouths of specimens open by a wad of cotton or paper; and turtles should have the feet drawn out. Alcohol of the full commercial strength should not be used for preserving. It is much better to put reptiles in alcohol diluted with an equal part of water for the first 24 hours and then into alcohol with one fourth of its volume of water. For batrachians, alcohol even weaker than this should be used; at first with two thirds water and after 24 hours with one third water.

Labels of strong paper should be attached to the specimen but should never be tied around the neck. For lizards and salamanders, fasten it around the body just behind the fore legs; for frogs and toads, in front of the hind legs; for snakes, around the body at about the anterior third; and for turtles to one of the legs. The labels should be written with a soft lead pencil and should contain: 1) the exact locality where captured; 2) the character of the soil and vegetation where the specimen was found, whether on sand, among rocks, under logs or stones, in holes, swamp, meadow, forest or any such observations; 3) date of capture; 4) collector's name.

After soaking in alcohol for from one to two weeks, according to size, they are ready to be transported. For this purpose, a cigar box, an old tomato can, or, better still, an empty baking powder can, will serve. Take some cotton batting, soak it in alcohol and squeeze it nearly dry; then wrap each individual specimen up and pack solidly in the box or can; when the can is full, add as much alcohol as the contents will hold without dripping; wrap the parcel in several thicknesses of strong paper, tie securely and forward by mail, if not too large, to the State Museum, Albany N. Y.

If there are not enough specimens to fill the can, fill it up with cotton. Do not use glass, as it is liable to break.

Living specimens of any of the forms except the larger turtles would be specially valuable and may safely be sent by express (collect). They are best sent in soft damp moss so as to keep them from jarring.

Notes on the following points are greatly to be desired: the occurrence of species in any locality and the conditions under which they were found; their first appearance in the spring and frequency of occurrence throughout the summer; their food and mode of life and their times of breeding and breeding habits.

Any notes or specimens sent to the museum will be acknowledged and full credit given in the Museum reports and any further publications.

INDEX

The superior figures tell the exact place on the page in ninths; e. g. 399^3 means page 399, beginning in the third ninth of the page, i. e. about one third of the way down.

(Pages 415–416 were bulletin cover pages)

Published monthly by the
University of the State of New York

BULLETIN 259 JULY 1902

New York State Museum

FREDERICK J. H. MERRILL Director
JOHN M. CLARKE State paleontologist

Bulletin 52

PALEONTOLOGY 6

REPORT OF THE STATE PALEONTOLOGIST

1901

University of the State of New York

New York State Museum

Frederick J. H. Merrill Director
John M. Clarke State paleontologist

Bulletin 52 April 1902

REPORT OF THE STATE PALEONTOLOGIST 1901

To the Regents of the University of the State of New York

I have the honor to report herewith on the work of this department during the year commencing Oct. 1, 1900.

Operations in the field 1900-1

Investigation of problems pertaining to the fauna of the Ithaca group of central New York. In my report of last year notice was taken of the fact that the legislature of that year had provided for investigations having special reference to the relations of the Ithaca formation and its fauna to contemporaneous organic and inorganic conditions at the east and west of the central New York area as well as to such conditions as immediately preceded and succeeded them in time. As a preliminary step to the solution of the problems involved, which were stated in some fulness in the report referred to, it was essential that extensive collections be made from the fossiliferous strata throughout the various outcrops of this district. For a large part of the season of 1900 this work was carried on, specially in the region from Otsego county westward into the Chenango valley and into the valley of the Tioughnioga river. The material sent in as a result of this work, largely acquired by D. D. Luther, field assistant, was in many respects of high paleontologic interest, not alone in bringing to our attention organic forms hitherto unknown in our rocks, but specially in completing series which clearly point to the fact and the course of development and variation of early species into later. In

view of the unusual conditions under which the sediments in this part of the state were deposited, and under which its organisms flourished on these ancient sea bottoms, the lessons to be derived from the results hitherto acquired are very instructive. Furthermore, besides the novelty of much of the material thus brought together, we have acquired for the collections of the state museum an important new element; for in the past the fossils of this Ithaca formation have been largely confused with the organisms from the rocks beneath, and up to this time the state museum has had only the most meager and uncertain representation of this noteworthy element in the sequence of New York faunas.

The operations in this part of the state were not concluded with the closing of last season's work, and during the season of 1901 the investigations, so far as the acquisition of material is concerned, have been continued and completed by covering the region between the Tioughnioga river and the valley of Cayuga lake. This work of collection was carried on by C. A. Hartnagel with the assistance of H. S. Mattimore, and localities throughout southern Cayuga, western Cortland and Tompkins counties were carefully exploited. We have now the material for the elaboration of various peculiar problems which come into view relating to the origin and the destiny of this Ithaca fauna and also the data for confirming previously expressed views of its relations to the faunas of contemporaneous age which adjoin it on the east and west.

It may be here of special interest and usefulness to note that the period of time in which the Ithaca deposits were laid down, that is the Portage unit of time, was marked within the limitations of the state of New York by the manifestation of at least three distinct geographic faunal provinces, one in the east, the Oneonta province, where fresh-water conditions prevailed as in a coastal embayment or lagoon, receiving fresh-water drainage from the continental plateau; next west, the province of the true marine fauna which we know as the Ithaca fauna and which owes its derivation directly to the fauna which preceded it in time in this mediterranean sea or Appalachian gulf; and,

still farther westward, that of the Naples fauna, which is an invasion from the far northwest and occupies all the ground from the meridian of Cayuga lake to the shores of Lake Erie. Furthermore, the region occupied by the invading Naples fauna is clearly divisible into two subprovinces, that east of the Genesee river (Naples subprovince) into which the advance or herald species of the fauna penetrated, and the western (Chautauqua) subprovince, or that beyond the Genesee river, from which the advance species of the invasion had in notable measure departed on their journey eastward, but which those following in their train and pertaining to the same invading body had not passed. No parallel illustration of the intrusion of so diverse organic associations or faunas into an area so restricted as that here concerned between the valley of the Delaware river and the shores of Lake Erie is recorded so far as our present knowledge goes.

Study of waterlime strata and their fossil contents. During some years past study has been made of the character and variation in the succession of the waterlime series, which in our present classification of the New York rock series is regarded as pertaining to the geologic units termed Rondout and Manlius. The field investigations in this work have been carried on largely by D. D. Luther, and the results have been important in showing the degree to which the strata vary in character from one locality to another, but have been specially profitable in the light which they have thrown on the nature of the peculiar fauna inclosed by these sediments and in the new and interesting contributions to paleontologic facts which they have brought out. Several of the problems resulting from this series of field investigations have yet to be carefully studied to be appreciated in their full significance. Aside from the well known crustaceans (Eurypterus, Pterygotus, etc.) of these waterlimes which are produced in such remarkable perfection and profusion at the cement quarries at Buffalo, and in certain natural outcrops along the edge of the formation at Union Springs, Cayuga co., and Jerusalem hill, Herkimer co., the asso-

ciated species have received but comparatively little attention. The study of these has indicated the probability that we may not be altogether secure in the time-honored interpretation and correlation of some of our other strata having similar lithologic characters, such for example as the Coralline limestone of Schoharie county and the waterlimes of eastward sections. The fauna of a specially interesting outcrop of dark dolomite appearing on Frontenac island in Cayuga lake, where it is intercalated between the waterlime strata, will, when fully studied, give important aid in the interpretation of the proper relation of these beds to those which they immediately precede in time and to which they are otherwise allied, that is to the true Helderbergian strata. Collections were made at and about Jerusalem hill, and these operations were not concluded at the time of my last report. It may be briefly stated that the sum total of the latter work, which was devoted specially to the acquisition of the crustacean remains at this locality, has afforded us much interesting and unique material, not only increasing our knowledge of these unusual and peculiar creatures, but also yielding important evidence as to their early stages, their mode of development and habits of life. I note here the fact that from these collections we have obtained not only the most minute of these creatures yet recorded, but also the remains of the largest; heads of Eurypterus not $\frac{1}{10}$-inch across, indicating young forms not above $\frac{1}{2}$ inch in entire length and fragments of a single individual of the genus Pterygotus which could not have been less than 5 to 6 feet in length and thus representing one of the largest known of all invertebrate fossils, surpassing probably in size the similar crustacean, Stylonurus excelsior, whose parts have been found in the Catskill or late Devonic rocks of this state.

Paleontologic and stratigraphic map of Canandaigua lake region. In pursuance of a widely expressed desire on the part of many American geologists that the effort be made to portray on maps with more exactitude and fulness the paleontologic facts or actual succession of vital events in the earth's history, I have

undertaken to give a representation of such facts in a region that has been studied in great detail, perhaps with more care with reference to the succession of its fossil faunas than any other equal area in the state. The early maps of the sedimentary rocks of this state, like those prepared in other countries, combined all available data, organic and physical, for the delimitation of the formations; but the so called "geologic maps" of today do not attempt the representation of anything further than the succession of sediments or lithologic units. It is therefore, not possible that such a map tell the whole truth, for faunas do not vary *pari passu* with sediments. These geologic maps representing a succession of lithologic units display in a general way, it may be said, the facts which strike the ordinary observer most forcibly, such as the change in character of the rock, which may not however harmonize with the registration of the more essential facts of the earth's record; they are properly designated lithologic maps, as they express only variations in the character of the sedimentation. The true history of the earth is less the record of the successive changes in the nature of the materials that enter into the constitution of its crustal masses and of the physical events which have induced such changes, than it is a register of succession of the forms of life which have appeared on the earth in consecutive units of time. The history of the earth with this vital and organic element eliminated is the history of a body dead to begin with and always dead. Let it be invested with the manifestations of the life force in its manifold variations from the beginning to the present, and the earth's history becomes a record of vital interest.

Experience has further shown in the preparation of geologic maps in the state of New York, on the scale of the U. S. topographic base map, that this scale is either too large or our stratigraphic data are insufficiently refined. The quadrangles, stratigraphically colored, that we have thus far issued indicate this fact by displaying for the respective formations represented very broad bands of color with insufficient differentiation;

accurate in fact so far as the contacts of formations can at present be made out, but with inadequate detail in showing the changes and variations in the sediments and in the associations of the organisms they contained. It is not to be inferred that such maps are not of great usefulness. They are the most exact that we have thus far been able to produce and have unquestionably served a useful purpose to those who have had occasion to employ them.

In the region about Canandaigua lake, where years of careful study have given us a very detailed knowledge of the changes in sedimentation and the variations in the successive faunas, we have undertaken to color the two quadrangles known as the Canandaigua and Naples sheets, the former lying directly north of the latter and giving an area which completely encircles that lake and affords a rock succession from the horizon of the Salina gypsum beds upward into the basal beds of the Chemung, a vertical thickness of about 3000 feet. During the present season these sheets have been geologically colored, and the detail of the stratigraphy completed with all practicable accuracy; disregarding slight local changes, we have found it possible to represent variations in the sedimentation by a series of 26 colors, where, using the ordinary colors hitherto adopted, one for each of the usually recognized formations, nine or 10 would have sufficed. Corresponding with this detailed stratigraphic map on which it is planned to register every outcrop of the rocks as well as approximately every contact, I have prepared a map on the same base showing the succession and variation of faunas, or what may be termed a true paleontologic map. It is proposed to issue these maps as companion sheets and to illustrate by means of them the actual relation of major variations in faunas to variations in sedimentation. In the field work necessary for the completion of the stratigraphic part of this map, D. D. Luther has supplemented the records made by the paleontologist and himself during the last 20 years.

Areal geology of the Tully quadrangle. Early in the field season it seemed desirable for the purpose of accurate delineation

on the geologic map of the state, and to establish a base mark or guide for the plotting of the formations immediately above and below, to trace the outcrops of the Tully limestone from Owasco lake eastward into Madison county. Mr Luther was engaged for a short time in the work of locating these outcrops on the Tully and Cazenovia quadrangles. The Tully topographic sheet lies directly south of the Syracuse sheet and covers a very interesting section of the rock series. It has therefore seemed desirable to complete the areal work on this sheet, and this will be finished before the close of the present field season. The field work is in charge of Mr Luther.

Contact lines of formations in the region about Tonawanda and Oak Orchard creek swamps. The great swamp area lying east and west along the course of the Tonawanda creek and its branches and extending to the northeastward along the Oak Orchard creek and its tributaries, covering a vast acreage in the territory between Churchville at the east and Buffalo at the west, a distance of 75 miles, has naturally obscured the rock geology of a very large area in western New York. The question as to the direction and position of the actual contact lines of formations on which this lowland rests came up during the course of the season in the special consideration of a relatively new member in our succession of faunas lying at the top of the Niagara escarpment, the so called Guelph fauna of the Rochester section, to which fuller reference will be presently made. This depressed region, lying largely between the escarpments of the Lockport dolomites on the north and the Onondaga limestone on the south, has not been the subject of extended geologic investigation, and so far as my knowledge extends no careful traverses of it for the end which has now been in view, have been made since the early survey of 1836-43. The very great scarcity of outcrops, the depth of the drift mantle, and the generally unbroken and monotonous aspect of the country from a geologic point of view, have rendered the attempt to trace the formational contacts one of some difficulty. The paleontologist, accompanied by Dr Ruedemann and D. D.

Luther, has made a series of traverses across this region, zigzagging from the Niagara escarpment at the north back and forth along various meridians. It is perhaps not altogether a contribution to the geology of this region to state that the evidence obtained brings out quite clearly the fact that a proximate cause of this area of heavily timbered swamp land, which the state has unavailingly attempted to redeem, is the removal of vast amounts of soft shale at different geologic horizons, leaving as the actual rock bottom of the depressions a pavement or sill of heavy limestone; thus, by the removal of the Rochester shale which lies on top of the Clinton limestone, deep depressions running east and west along the strike of these formations were produced, and hence we find that some of the northerly branches of the swamp area, specially those of the Oak Orchard swamp, rest on a bottom of limestone from which this soft shale has been excavated. These areas are in a certain measure cut off from the large area of the swamp which has been produced by the removal of the soft Salina shale from the limestone or dolomites pertaining to the Niagara formation. Hence the great swamp area generally speaking lies on a pavement of Lockport dolomite, and by the outcropping ridges of this dolomite it is more or less distinctly cut off from the smaller swamp areas lying to the north. The removal of these large amounts of soft rock may be freely ascribed to erosion by stream action, and we find both in the Tonawanda and Oak Orchard creeks—streams whose main courses lie approximately east and west—a remnant of a force which would produce and probably has produced depressions of this kind along the strike of the rocks. While the removal of such large quantities of soft rock lying between formations of harder and more resistant texture may be looked on as the occasion for the existence of these swamps, the cause of their present actual extent and transgression of geologic barriers is doubtless to be found largely in more recent damming of the waterways required by the construction of the Erie canal, obstructing the natural drainage of the whole territory and rendering the actual run-off insufficient and incomplete. In an appendix to this

report I have given further detail as to the results of field work in this area with special reference to locating the formational contact lines, and it may here be stated briefly, that the outcome of this work has been to correct in some important particulars these lines as heretofore registered on our geologic maps. Because of the scarcity of outcrops, however, the course of these contacts may always remain more or less conjectural.

Stratigraphic and paleontologic relations of Potsdam sandstone of the Lake Champlain basin to overlying limestones. During some years past Mr Gilbert van Ingen, special field assistant, has been concerned with the study of the fauna of the lower limestones of our rock series, specially those of the Beekmantown and the Chazy horizons as developed in the basin of Lake Champlain. These formations have furnished a large amount of new evidence as to the constitution of the faunas of the times they represent. Having acquired special familiarity with the faunas of these rocks, Mr van Ingen has at my request undertaken during the last season to study the relations which they bear to the underlying Potsdam sandstone, and to ascertain in how far the passage from the latter upward into the former is gradual and what evidence the fossils afford in regard to the transition of the earlier fauna to the later. The ultimate purpose of this inquiry is to determine to what degree the fauna of this ancient Potsdam period bears characters which may fix its age as Cambric. Historically this well known formation is the basal member of the "New York series of formations" as enunciated by the four geologists of the early survey. Dr Ebenezer Emmons, in defending, against the convictions of his colleagues, the existence of a series of still older fossiliferous sediments (the Taconic system) did not propose to embrace with them the Potsdam sandstone, a formation of which he also was the demonstrator. The Potsdam sandstone is furthermore clearly a shallow water or littoral deposit accumulated along the shelving shores of the most ancient crystalline continent, and is the oldest deposit of this character of which we have any knowledge in our rock series. Farther out at sea in the

deeper waters were laid down contemporary deposits, which doubtless included a richer congeries of organic forms. What these deeper water deposits were, where they are and what they contained are facts necessary to ascertain before we can arrive at a precise conception of the succession and correlation of our Cambric deposits. In a supplementary chapter Mr van Ingen has given a brief summary of his season's work on this problem.

Limestone lenses in the Clinton beds. In previous reports record is made of the fact that one of the problems under interrupted investigation by the department, is that relating to the origin of the peculiar lenses of unstratified semicrystalline limestone which have been observed at various outcrops along the Niagara cuesta from Lewiston to near Rochester. These lenticular masses of large size, often fully 30 feet in diameter, are either embedded in the well stratified and clearly jointed Clinton limestone, or lie near the upper surface of that limestone and are overlain by the shales of the Rochester beds. The occurrence of these peculiar rock forms, recorded first by Dr E. N. S. Ringueberg of Lockport and subsequently noted by G. K. Gilbert, their nature, origin and faunal composition have been the subject of study; and it has before been noted that a series of these rock bodies begins near Lewiston on the line of the Rome, Watertown & Ogdensburg railroad, where several are exposed, are seen also in beautiful display on the rock face along the line of the New York Central railroad just south of Lewiston, also at Gasport in considerable number, and at Middleport. Dr Ringueberg's early observations on the faunal contents of this peculiar rock served to indicate an association in some degree foreign to that of the rocks with which it is most intimately associated but with which it is never blended. The fauna is not that of the Clinton rocks of New York nor of the Rochester shales; though carrying a considerable representation of these faunas, its most conspicuous species are those which have been described as occurring in western faunas usually ascribed to the Niagara group. The observations on

these lenses which were made by the paleontologist in 1899 and 1900 have been supplemented during the last year by a fuller and more careful study of the field conditions by Prof. A. W. Grabau of Columbia university. Dr Grabau has had as associates in this work H. W. Shimer of Columbia university, R. F. Morgan of Buffalo, T. W. Peirson of Lockport and Charles Ewing of Middleport, all of whom in this work volunteered their services.

Evidence of these lenses has been found at Lockport; on the east side of the "gulf" and north of the Niagara road is an exposure of several of them lying on the shelf formed by the Clinton limestones. One of these could be located only by presumption, as its site seems to be covered by the embankment of the new electric railroad. Two other lenses are exposed within a short distance of each other, and these apparently rest on the surface of the Clinton limestone. The greatest thickness of these two bodies was 3 to 4 feet, though this may have been reduced by long weathering. Compared with the lens outcrops farther west in the vicinity of Lewiston, these at Lockport did not prove very fossiliferous, the principal fossils being Lichenalia and W h i t f i e l d e l l a n i t i d a. The lithologic structure of the rock however, a subcrystalline, unstratified mass of hardened, calcareo-magnesian mud, is very characteristic and in harmony with the traits displayed at other localities. Heretofore actual exposures of these lenses have not been recorded at Lockport, Dr Ringueberg's original description having cited only loose blocks of this material in this neighborhood. In the northern part of the city of Lockport, in the rear of William Stamp's lot on Jackson street, and on land owned by Mr Mansfield, several large masses of the same rock are exposed. These rest on the limestone ledges of the Clinton, which here form a shelf of some width. This exposure would seem to indicate not less than two separate rock bodies.

Between Lockport and Gasport none of these lenses have been seen, exposures everywhere being unfavorable for their exhibi-

tion. In the ravine of a branch of Eighteen Mile creek south of Gasport lenses are of very frequent occurrence, as I have noted in a previous report. East of the road leading south from the village, along the edge of the stream a number of these, stated by Dr Grabau to be not less than 20, have been observed within the space of ½ mile, and others appear in the ravine west of the road. These all lie in the upper part of the Clinton limestone, and the majority are shown in the bed of the stream, the original covering of the limestone having been entirely removed, though some still show the covering layers of the limestone for a foot or so in thickness, arching upward over the lens, forming a domed surface of exposure. A similar phenomenon is observable in the occurrence on the New York Central railroad at Lewiston, where the arch and dome are formed by the Niagara shale. At Gasport fossils are more abundant in the lenses. At Middleport no other evidence of the lenses is to be found than the single one located by the paleontologist two years ago and largely removed at that time for the purpose of obtaining its fossils. This lies on Jeddo creek on the land of Mr Ewing and appears to rest on top of the upper Clinton limestone and to be covered by the Rochester shale. Though the shale has been removed from the lens itself, a bank of it is not far away, and evidence of it is present about the edges and on the lower side of the lens.

There is some evidence of variation in the character of the fossil contents of these rock bodies, according to geographic position. Those on the Rome, Watertown & Ogdensburg railroad near Lewiston appear to be the most highly fossiliferous of all, parts of them being impregnated with masses of separated shields of the trilobite Illaenus, which have been washed together and piled up like saucers; they are also very rich in cephalopods of unusual species, (Orthoceracones and Cyrtoceracones), brachiopods, etc. These species are apparently less abundant in the lenses at Middleport and Gasport; but we are not at present able, from the evidence in hand, to determine in how far there is a meridional variation in

the fossil contents of the series of lenses. Dr Grabau and his assistants have sent in a considerable amount of material which will aid in the solution of the organic feature of the problem. The observations thus far made on these lenticular bodies seem to indicate that they were substantially hardened masses in the sea bottom before the succeeding deposits were laid down over them. It may be said with comparative security, that the faunal content was in considerable measure an importation from the west or southwest. To what degree the sediments were tidal barriers, and the concentration of the fauna in this peculiar form due to the dragging action of tidal currents or accumulation by other mechanical action, and in how far the species represent an actual brief invasion, is yet to be determined.

Phenomena of like character to those rock masses are found in the "Klintar" which constitute striking headlands on the sea wall of the island of Gothland in the Baltic sea. These are lenticular masses of dolomites without sedimentation structure, lying involved in upper Siluric strata of age equivalent to that of the Clinton and Rochester beds of New York. They have been shown by Wiman[1] to be the product of reef-building organisms (corals and bryozoans), though now by wave detrition and by dolomitization but faint trace of such organic structures appears in the rock itself. The Clinton reefs are so impregnated with organisms of form unusual to the contemporaneous deposits of the western New York province as to raise the question above referred to concerning the influence of tidal currents in spreading out on these barriers extralimital organisms from adjoining provinces.[2]

---

[1] Ueker silur. Korallenrippe in Gotland. Geol. instit. Upsala. 1897. v.3. pt 2, p. 311.

[2] Since the above paragraphs were written, the nature of these peculiar rock masses of the Clinton beds has been made the subject of a careful paper prepared by C. J. Sarle (Am. geol. Aug. 1901. p. 282). The author has registered the occurrence of a considerable number of these rock bodies and has brought together much evidence confirmatory of their reef structure.

Guelph horizon and its fauna in the sections at Rochester and westward. At the meeting of the American association for the advancement of science at Rochester in 1893, Prof. Albert L. Arey, then of the Rochester free academy, now of the Brooklyn girls high school, drew the attention of the geologists present to his discovery of a fauna lying in strata at the top of the Lockport dolomite series. These fossils, remarkable for the beauty of their preservation, were obtained by Prof. Arey in nodules of white chert found in the upper dolomite layers at a quarry in the southwest part of the city, then being worked and known as Nellis's quarry, and also from excavations for municipal improvements made in the southern streets of the city. Shortly after this discovery a representative series of the fossils was submitted to the paleontologist for examination, and it was then proposed that a joint description of this interesting new contribution to our New York faunas should be prepared. Subsequently the fauna was carefully studied by its discoverer and brought into comparison with the characteristic Guelph fauna, which is extensively and typically developed in the province of Ontario, and the results of this comparison, which did not extend to the details of specific identification, were set forth by Prof. Arey on the occasion referred to, and also published in the proceedings of the Rochester academy of science, vol. 18. Only an inkling of the presence of such a fauna in the New York rocks had before gone on record. As long ago as 1843[1] Prof. Hall noted the presence of certain species from what are believed to be the dolomites of this same horizon; and in that report and in his subsequent account of these fossils of the Niagara and Salina rocks in vol. 2 of the *Paleontology of New York*, they were ascribed to the beds of the so called "Onondaga salt group," the Salina formation of our present nomenclature. Prof. Hall's localities for these fossils were at or near Newark, Wayne co., but we have no other than the original record of them. Exposures of this upper narrow horizon along the summit of the

[1] Geol. N. Y. 4th dist.

Niagara escarpment are so rare, and the cuesta has been so seldom trenched either by natural or artificial means, that till Prof. Arey's discovery, it may be said that we were in almost complete ignorance of its presence. In and about Rochester the fauna seems to have attained a localized development to a profusion not observable elsewhere in the state. During the last year Prof. Arey has, with great consideration, placed his collections of those interesting fossils in the hands of the paleontologist for study. We have found that the material represents a fauna of about 50 species, of which 19 appeared (Niagaran) previously in the same locality, 4 are peculiar to the congeries itself, and 21 are present in common with the typical Guelph fauna of Ontario. It is thus clear that the fauna is not simply a local expression of a late stage of the Lockport dolomite fauna, but represents the true Guelph fauna of Ontario. It is possible that the collection we have had in hand does not fully exemplify the fauna, but, as Nellis's quarry is now abandoned, and there appear to be at present no excavations within the city of Rochester into this formation, we have been at a loss to add to the material already taken out from this region. Field investigations have been made with care for the purpose of tracing this horizon, which, it may be added, is hardly to be separated from the dolomites beneath by lithologic characters, to the west and east of the vicinity of Rochester. The most complete section of the dolomites in the immediate vicinity of the city appears to be that on Allens creek just to the south, where shaly layers clearly referable to the basal beds of the Salina and chocolate colored dolomites which pertain to the Lockport dolomite series are exposed, but with a covered interval just where one would expect to find the Guelph horizon. In transecting the escarpment at various points between Rochester and Lockport slight traces have been found of the position of this stratigraphic horizon, specially at the excavations on the Orchard creek canal feeder south of Shelby, where the abundant nodules of white chert in the compact dolomite indicate species of similar character to those at Rochester but in a condition of less satisfactory preservation.

During the prosecution of this study of the New York Guelph horizon and the distribution of its fossils, typical localities in the province of Ontario were visited, the sections of the strata carefully studied and quite extensive collections made at Galt, Hespeler and Elora. The earliest fossils described from the Canadian sections were those given by James Hall in vol. 2, *Paleontology of New York*. Prof. Hall visited the region in 1847 before the stratigraphic relations of the series had been carefully studied by Sir William Logan and Robert Bell. Hence, in describing the organisms collected, he referred them to the "Onondaga salt group" together with the few remains taken from what he then believed and what has since proved to be the same horizon. The Canadian paleontologists, principally Dr Whiteaves, have given full accounts of the composition of the Guelph fauna, and at the time the collections were made for those studies, Elora and Hespeler were the most productive of the localities; latterly, through a diminished demand for the rock for construction purposes, less is now accessible at these localities in favorable condition for exploitation of the fauna, and neither is at present as interesting or productive as the various exposures about the beautiful village of Galt.

As shown here, the rock section begins on the east side of the bank of the Grand river just below the Grand Trunk railroad station (Ballantine's quarry and kiln), where are exposed, reading from the bottom:

1 A yellow, very sandy dolomite in compact layers carrying Megalomus in immense quantities and numerous gastropods, 10 feet;

2 Thinner and grayish slabby dolomites running up to and above the railroad track, 20 feet;

3 Darker, compact dolomite, 5 feet;

4 Thin, grayish yellow, slabby layers with gastropods, 10 feet.

The entire section from the river bank to the top of the bank above the limekiln is not less than 55 feet. This locality proved to be the best in the vicinity for the acquisition of the characteristic fossils of the fauna. The lower layers of yellow dolo-

mite when wet become softened, so that they break freely in any direction. The fossils, however, as everywhere in these rocks, are internal and external casts, and special pains were taken to secure specimens showing the characteristic exterior characters of the organisms.

On the opposite side of the Grand river are exposures at Hogg's and Webster's quarries, the latter a small opening of the basal layers on Crumby street, which furnished many interesting species. Just above the upper bridge on the east bank is a slight, unworked exposure of the upper compact, gray, slabby dolomite, which is profuse in gastropods. Melross's quarry, 1 mile north of the village on the east bank of the river, exposes a yellow dolomite 15 to 20 feet thick, running into a heavy bed toward the top. This rock is full of Megalomus, but good specimens of other fossils are not common, and gastropods less frequently seen. This outcrop lies about 2 miles north of Ballantine's quarry and is probably about 50 feet higher, completing the section at Galt, which can not be less than 100 feet thick.

All these outcrops are along the strike of the formation, and Sir William Logan regarded the strata here as representing the middle part of the group, those at Hespeler on the river Spree being in his judgment below this horizon, while the striking natural section at Elora, about the confluence of the Grand and Irvine rivers, where the canyon is not less than 100 feet deep, is considered the summit section of the formation. The series of fossils obtained from all these Guelph localities will constitute a useful addition to our museum collections.

Limestones of the Marcellus stage and origin of their faunas. The Marcellus formation is typically represented by a series of black bituminous shales, carrying a fauna which has peculiarities so well marked as to render it readily recognizable. Among these shales there occur in different sections interbedded limestones which are specially noteworthy for the diversity of their organic contents. Thus in eastern sections some 30 feet above the base of the shales lies the series of limestone banks which has been

known in geologic literature as the *Goniatite limestone*, or, employing the designation derived from the characteristic fossil of the rock, the *Agoniatites limestone.* These beds are most fully developed in the eastward counties of the state and gradually lose their individuality westward, disappearing just west of Seneca lake. While this limestone is absent in the western counties, another appears at a higher horizon in the shales and carries an altogether distinct series of fossils. To this limestone I applied some years ago the geographic name of Stafford limestone. We find in sections at the very base of the Marcellus sediments, specially in western New York, still a third impure calcareous deposit which was shown in the section of the Livonia salt shaft and recently has been exposed at Stony point south of Buffalo on Lake Erie. This also has a fauna peculiar to itself in many respects. Thus we have represented in this period of deposition several quite distinct faunal associations, and they have raised the interesting question as to how and whence these faunas have come into our state. The investigation of this proposition has been in a large measure a summarization of observations made by the paleontologist during the past years, but, in bringing these together for formal expression, much assistance has been received from Prin. John D. Wilson of Syracuse, who for some years past has been a diligent student of and collector from the Agoniatites limestone as exposed in Onondaga county and in his work has made some interesting contributions to our knowledge of the fauna of these layers. Some field operations in this connection have also been prosecuted in Schoharie and Otsego counties with interesting results, as detailed in a paper on this topic, communicated in museum bulletin 49, which is also accompanied by an account of the section of the Marcellus limestones as exposed at Lancaster, Erie co., by Miss Elvira Wood, instructor in paleontology in the Massachusetts institute of technology, an investigation which the author has executed with care and exactitude.

Character of the so called Hudson river beds of the northern Hudson valley. In continuation of the study of the nature and composition of the formation which has been known in geologic

literature as the *Hudson river slates*, Rudolf Ruedemann, assistant paleontologist, has extended the work previously done and reported on, in the vicinity and to the south of Albany (museum bulletin 42) northward into the upper reaches of the Hudson valley and the general field of exposure of the formation in this direction. On the west side of the river the Lorraine and Utica beds have been traced as far as Mechanicsville; on the east side the Utica, middle Trenton and Normans kill shale were followed only a few miles northward to the long outcrops on the Deep kill in Rensselaer county. At this point a most interesting discovery was made in the finding of beds containing a very unusual graptolite fauna in a fine state of preservation; such a fauna as was described at an early date by the late Prof. Hall from the so called Quebec shales of Canada. Of this fauna nothing has before been known in the state of New York, and the presence of these fossils here in such abundance affords not only important points of correlation of the New York with the Canadian faunas, but again adds in a notable and interesting way to the ancient faunas of the state. Though this fauna is embedded in the "Hudson river slates", its age as indicated by the character of its fossils is doubtless to be ascribed to that of the Beekmantown formation, and represents in an unbroken succession the faunas of horizons which have hitherto in America been known only separately and without any clue to their chronologic sequence. From a biologic point of view the interest of the discovery is greatly enhanced by the presence of innumerable growth stages representing the entire development phases of many forms, from the embryonic stage to the fully developed colony. This interesting section occurs near the town of Melrose in northwestern Rensselaer county, and its graptolites are representatives of the genera Phyllograptus, Tetragraptus, Loganograptus, Dichograptus, etc., which have hitherto been foreign to our faunas. Four different aggregations of graptolite-bearing shales were found in the thick mass of thin bedded limestones and greenish grits which compose the outcrop; and, as the aggregations or faunules are

distinct in their composition, it is believed that exact correlations will be possible even with regions so remote as the sections in Scandinavia, on the continent of Europe and in Australia, for these organisms seem to have maintained to a degree not displayed by others their value as time-markers in the succession of the early Siluric rocks.

1 The lowest horizon is characterized by innumerable examples of Didymograptus, specially D. nitidus and D. patulus.

2 The next fossil-bearing beds are the richest in species, and the state of preservation is the most excellent. They contain a Tetragraptus and Dichograptus fauna, nearly all the species of these genera, which were described by Hall from the Quebec beds, and several additional ones being present. The fauna of these two horizons combined is that reported from the "main Point Levis zone" of Hall. This has been referred to the lower Calciferous or Beekmantown formation.

3 Farther up the creek is another series of graptolite beds characterized by Didymograptus bifidus and Phyllograptus anna, these two species comprising the majority of all specimens. Neither of them occurs in the first two horizons, but they are characteristic forms of the Phyllograptus anna zone of St Anne river, Quebec.

4 Next follows the great mass of the quarry beds consisting of heavy banks of greenish grits with thin shaly partings, the latter carrying innumerable specimens of Phyllograptus typus, P. anna and P. angustifolius. Besides these Didymograptus bifidus, D. similis, Thamnograptus anna and others. They probably represent the upper part of the Phyllograptus anna zone.

5 About 800 feet farther up the creek are two narrow black bands intercalated in the dark greenish gray, barren shales, which carry a very luxuriant assemblage of fossils, having not less than 18 species, all of which are new to the New York faunas. Two of these are brachiopods, viz: Lingula quebecensis and a large oboloid representing a new generic

form. The characteristic graptolite constituents of the fauna are Diplograptus pristiniformis, D. inutilis, Trigonograptus ensiformis, Cryptograptus antennarius, Retiograptus tentaculatus, Dictyonema, four new species belonging to the rare subgenus Desmograptus, hitherto represented by but a single species in America. This association of forms which is made strikingly distinct by the introduction of the diprionid element appears to be identical with one mentioned by Prof. Hall as occurring at Point Levis, and which is correlated by Gurley in his list of the North American graptolites with the upper Beekmantown horizon. Thus the zones which have elsewhere been held to represent lower, middle and upper Beekmantown horizons are here exposed in continuous section. It is hoped that a more extended study of these beds will furnish the data for an exact determination and subdivision of the graptolite horizons throughout the Beekmantown formation, and it is also purposed to present a careful paleontologic study of the graptolites themselves. In the appendix to this report Dr Ruedemann analyzes the section in greater detail and also gives under separate title an account of the development of one of the graptolite species, Goniograptus thureaui.

Monroe mastodon. Late last season my attention was called to the discovery of mastodon bones which had been made some time previously near the village of Monroe, Orange co., on land belonging to Martin Konnight. On visiting the spot, it was ascertained that the bones found were in the possession of George Konnight of Monroe and had been taken some years ago, while drawing muck from a pond bottom which had been exposed by a protracted season of drought. All the bones obtained at that time had been kept together with care by Mr Konnight. The situation at Monroe was as follows. Just below the village at the north side of the highway leading to Turner, lies a pond about 250 feet in diameter containing, at the times of my visits, water to an average depth of 6 feet. On careful study of the topography of the region, it seemed prob-

able that this pond was cut off entirely from the lowland in the immediate vicinity, though the highway was tangent to its southern border, and below the highway the land spread off into a broad, gentle depression. The pond had no visible outlet, though it was pretty clear that the water found its way by seepage across the highway into the lowland beyond, and, as there was no visible surface inlet into the pond, it was a natural inference that the water was supplied to it mainly from the springs in the bottom.

Among the bones which were in the possession of Mr Konnight were the tusks of the upper jaw, which had become badly broken from long exposure but were still in condition to be mounted and which must have been from 8 to 9 feet in original length, the short tusks of the lower jaw, the occurrence of which is of very great rarity among these fossils, several ribs, a scapula, a tibia and other leg bones, some of the bones of the feet, etc. all of which except the upper tusks were in a condition of superior preservation. On comparison of their dimensions with those of some of the more complete mastodon skeletons, they indicated a skeleton of very great size, almost if not quite reaching the size of the Warren mastodon, the largest yet obtained from the surficial deposits of New York. The legislature was asked for an appropriation of $600 to effect the emptying of the pond and the excavation for the remaining bones, the fact being recognized that the accumulation of bones from so many parts of the body as were represented by those in Mr Konnight's possession, indicated a favorable opportunity for the acquisition of the remainder. This appropriation having been granted, the work of emptying the pond was begun in June and when all these preliminary operations were concluded the excavation of the muck in the bottom was begun. The labor of removing the water and keeping it out of the pond proved extremely arduous, as the water was found to enter the pond by several very large springs, and it was necessary, in order to keep the pond basin free of water, to work the gangs at the pump both night and day. This undertaking occupied a month

or five weeks, and the expense attending it was in excess of the estimate, so that, when excavation became possible, our means did not enable us to carry this to completion. The area of about one third of the pond bottom was carefully dug over, and additional evidences of the mastodon skeleton were found; but, as we had reached the limit of our appropriation and were in danger of passing beyond it and incurring an expense which could not well be borne, and as I was unable to obtain additional assistance from any private source, it became necessary for us to end the work with the excavations incomplete. Hunting mastodon skeletons carries with it a large element of uncertainty, as such skeletons are very rarely complete. The fluidity of the soil in which they have become mired disjoints and scatters the bones, with the result that the finding of one part or a considerable portion of a skeleton does not guarantee the presence of all the bones. The parts we have obtained have features of considerable interest, specially the lower incisors to which reference has been made, and the possibility of reclaiming the remainder of the bones is still about as good as it was at the beginning of the enterprise.

Cooperative work with the U. S. geological survey on the Salamanca quadrangle. In the season of 1900 the work which had been undertaken on the areal geology of the Olean topographic sheet was brought to completion, and the results carefully worked out both here and by the representative of the U. S. geological survey, Prof. L. C. Glenn. This work and report thereon will be published during the coming year. With the opening of the present season the work was continued to the adjoining quadrangle on the west (Salamanca), in which Prof. Glenn was associated with Myron L. Fuller of the U. S. geological survey. Charles Butts, who had during the previous season been the representative of this department in that work and who had prosecuted the stratigraphic and paleontologic determinations in the office during the winter, had in the meantime received an appointment as assistant geologist on the U. S. geological survey, but by the concession of M. R. Campbell, geologist in

charge of the work throughout this region and northern Pennsylvania, Mr Butts has been allowed to represent us in the acquisition of material necessary for paleontologic determinations from localities in the Salamanca area.

The work in the field as originally planned when the appropriation was made has now been brought to completion, and there remains but the summarization of the results acquired and the detailed representation of the stratigraphy on the topographic sheets. This will be the work during the coming winter of Prof. L. C. Glenn, and the completed map will be communicated to this department for publication, together with an explanatory statement of the detailed stratigraphic observations. Further reference is made under the head of office work to some of the paleontologic and stratigraphic results obtained from the work on the Olean sheet.

Personnel of the field staff

In the field operations of the department during the last season the following men, outside the permanent staff of the department, have been engaged: Prof. Charles Butts and Prof. Myron L. Fuller of the U. S. geological survey, on the work in Cattaraugus county; Prof. A. W. Grabau of Columbia university with H. W. Shimer of Columbia university, R. F. Morgan of Buffalo, Charles Ewing of Middleport and T. W. Pierson of Lockport on the investigation of the Clinton lenses in Niagara county; Gilbert van Ingen in the study of the Lower Siluric of the Champlain basin; C. A. Hartnagel of Hornellsville on the Ithaca group problems in Tompkins and adjoining counties.

Office work

Publications. The reports which were left unfinished at the time of the death of the late state geologist and paleontologist, Prof. James Hall, have now been brought to a conclusion and are all printed and issued. In regard to the memoir on the *Generic structure of the Paleozoic corals* which Prof. Hall had planned, I am able to report additional progress in spite of

obstacles to the satisfactory execution of the undertaking which have arisen. In the completion and final revision of this work some serious difficulties have constantly recurred because of the incertitude involving many of the specimens on which the investigations have been based, partly with reference to their actual geologic position and partly relating to their geographic locality. The material with which it was expected that the investigations would be continued belonged largely to the collection of Prof. Hall, and only a small part of this material has been since his death available for these studies. Notwithstanding these and other difficulties pertaining to its execution, I believe it practicable to present this subject in a form useful to students.

During the last year the following publications have issued from the department:

The annual reports for the years 1899 and 1900.

Museum bulletin 39, containing a number of papers relating to paleontologic and stratigraphic problems, as follows:

A remarkable occurrence of Orthoceras in the Oneonta beds of the Chenango valley, N. Y.;

Paropsonema cryptophya, a peculiar echinoderm from the Intumescens-zone (Portage beds) of western New York;

Dictyonine hexactinellid sponges from the Upper Devonic of New York, and

The water biscuit of Squaw island, Canandaigua lake, N. Y., by John M. Clarke;

Preliminary descriptions of new genera of Paleozoic rugose corals, by George B. Simpson;

Siluric fungi from western New York, by Frederick B. Loomis.

Museum bulletin 42, entitled the Hudson river beds near Albany and their taxonomic equivalents, by R. Ruedemann.

Museum memoir 3, entitled the Oriskany fauna of Becraft mountain, Columbia co. N. Y., by John M. Clarke.

Museum bulletin 45, Guide to the geology and paleontology of Niagara falls, by A. W. Grabau.

At the present time there are in press:

Bulletin 49, containing a series of paleontologic papers entitled:

On the Trenton conglomerate of Rysedorph hill, Rensselaer co., N. Y. and its fauna, by Rudolf Ruedemann;

Limestones of central and western New York interbedded with bituminous shales of the Marcellus stage,

New agelacrinites, and

Amnigenia as an indicator of fresh-water conditions during the Devonic of New York, Ireland and the Rhineland, by John M. Clarke;

Marcellus limestones of Lancaster, Erie co., N. Y., by Elvira Wood.

Bulletin (as yet without number) being a catalogue of the types of Paleozoic fossils belonging to the New York state museum.

With reference to the last named publication I enter into some further detail.

Catalogue of type specimens. For nearly three years, as opportunity has afforded, we have been carefully compiling a catalogue of the type specimens of the Paleozoic fossils of the museum collections. Though many of these important objects had been brought together by themselves, a large number were found to be scattered, sometimes without distinguishing mark, through the collections both in the State hall and in Geological hall. It has consequently been an onerous task to identify these and bring them together. This work is now virtually done, and we have in press at the present writing the completed catalogue of all of this valuable material. It is the purpose to present this catalogue in a broad biologic arrangement and to supplement this with tables showing the geologic distribution of the organisms through the rock series. While probably every year will subject the list to supplementary additions, as the work progresses or as more careful examination of our extensive collections reveals additional type specimens, at the present time the following is a statement of our possessions of this kind.

Total number of type specimens of paleozoic organisms, 5044. These are divided as follows:

Plantae	43
Sponges	141
Coelenterata	348
Echinodermata	115
Bryozoa	484
Brachiopoda	1132
Lamellibranchiata	1022
Pteropoda	56
Gastropoda	374
Cephalopoda	571
Vermes	102
Crustacea	643
Pisces	13

It is well known that 25 years ago the late Prof. Hall sold his large collection of fossils, on which in very considerable measure the studies in the early volumes of the *Paleontology of New York* were based, to the American museum of natural history in New York city; and from this fact the impression has in some measure gone abroad that the greater number of types of the *Paleontology of New York* are not in Albany but in the museum at New York. It is therefore perhaps appropriate that attention be here directed to the following statement with reference to what may be termed types of the New York paleontology in the possession of these two museums, lest misapprehension continue in regard to the location of such specimens. The curators of the collections of Paleozoic fossils in the American museum of natural history have recently published a detailed catalogue of their type specimens from which we draw the following:

Total number of type specimens, Cambric to Devonic inclusive, 4067. Of these the types figured in official New York state publications are 3626; types from the Paleozoic rocks of New York state figured in official state publications, 2696.

Of the 5044 types of fossils, Cambric to Devonic, in the New York state museum about 4500 are from the Paleozoic rocks of New York state, and with very few exceptions were figured in the official publications of the museum. These statements seem to require no further comment.

Catalogue of fossil faunas of the state. During a part of the year Mr C. A. Hartnagel was engaged in the compilation of a card catalogue of the fossil faunas of all our paleozoic rocks. Such lists have never been prepared, and a catalogue has seemed to me imperative to enable us to note in how far our own collections retain the recorded representation of these faunal lists. The work is however not merely one of compilation, but requires for its perfection much careful review, and the elimination of the synonymous names, and really for its best usefulness, a grouping which shall be a better expression of the relations of the faunas than the mere bringing together of the species under the general names of the formations. The lists are very large, running up into the thousands of species, and it is believed that it will serve a useful purpose to put this eventually in published form, as has been done for the ancient faunas of other countries.

Determination of Rochester shale fossils from western New York. Mr Hartnagel was engaged for part of the year on the determination of the fossils contained in a large amount of material brought in from the Rochester shale of Middleport and other localities in western New York. As the representation of the fossils of this formation in the state museum has heretofore been somewhat meager, though containing many fine examples, this work has served to extend our knowledge of the fauna and has added a number of hitherto unrepresented species to our collections.

Study of fossils of the Ithaca formation. In connection with the problems relating to the Ithaca fauna, to which fuller reference has already been made, Mr Charles Butts was engaged for some time on the identification of the material collected during the season of 1900. Mr Butts's familiarity with the species of the

higher beds enabled him to undertake this identification with very satisfactory results.

Iron pyrites bed at the horizon of the Tully limestone in western New York. Recent investigations of the stratigraphy of the Devonic series in western New York has brought out the fact that, from the point at which the Tully limestone reaches its western extinction close on the eastern shore of Canandaigua lake and from there westward to Lake Erie, its position in the succession of strata is unfailingly marked by a deposit of iron pyrites in the form of a thin sheet an inch or two in thickness, becoming in places discontinuous and nodular. It proves as reliable a bench mark in the strata as does the limestone itself, always maintaining the position of the limestone as the boundary formation between the Hamilton shales beneath and the Genesee shales above. This pyrite is usually very compact and hard, and in many places among the twigs, balls and pellets of evidently concretionary nature are entangled considerable numbers of diminutive fossils. At the meeting of the American association for the advancement of science at Columbus in 1899, the writer called attention to this peculiar occurrence in the hope of eliciting some expression as to the probable origin of such a continuous deposit of this peculiar nature extending unbroken for almost 100 miles. Considering that the deposit preceded a period of evidently shallow, inclosed coastal areas or embayments, where organic decomposition proceeded in such a manner as to impregnate the muds with bituminous matter (represented in the black shales of the Genesee), it seemed natural to conclude that the environment which conditioned the formation of this iron sulfid was also due to excessive organic decomposition with generous liberation of iron oxids.

As long ago as 1885 the writer described a considerable number of organisms from this pyrite layer, recognizing the fact that they presented similarities to species of the preceding or Hamilton fauna, but their diminutive form seemed to render actual identification of them with previously known species insecure, and hence for the most part they were described as new

forms. The facts set forth have raised several interesting questions, among them the problem as to how far a fauna gradually or suddenly involved in such conditions as this deposit of metallic sulfid indicates could survive and with what modifications of form and structure life might be continued. We have found that the pyrite embraces representatives of various groups of animals, fishes, crustacea, brachiopods, gastropods, cephalopods, plants, etc., and all seem to have suffered in very much the same way from their surroundings, that is to say, with rare exceptions all have a diminutive size which may express an atrophy of function or an arrest of development. Some time ago I asked Dr F. B. Loomis of the biologic department of Amherst college to undertake the investigation of this problem. He has studied the matter with much care with material from various outcrops of the pyrite layer, has been enabled to free the organisms and identify them, and by a series of experiments has drawn some interesting conclusions as to the causes which have modified them and the conditions which prevailed over the sea bottom during the period of their life. Dr Loomis's results will be given in a future report.

Contributions to the geologic map of the state. In the compilation of a geologic map of the state by the state geologist, I have been pleased to place at his disposal all the data in the possession of this department which could in any way serve to render more accurate the delineation of the formational contact lines among the sedimentary rocks. These facts were those accumulated for this purpose by the late Prof. Hall and partly by myself under his supervision or independently. For the sake of the accuracy of this official map, I have also undertaken the determination by active field observations of some doubtful points, all in the hope that this map may, so far as the sedimentary rocks are concerned, express our best and most accurate knowledge of their distribution and classification.

Index to state publications on paleontology. The University has undertaken the preparation of an index or series of indexes to

the scientific papers issued under its supervision. To make this as complete as possible in its references to the paleontology of New York, I have undertaken to compile detailed references to the extensive literature of this subject, including references to descriptions of genera and species. To meet fully the purpose of such a compilation, it has seemed highly desirable that in this regard the list shall be exhaustive. The undertaking is one requiring considerable time, and it has been thus far carried forward in the intervals of more pressing work by Jacob Van Deloo, the clerk to the department.

Contraction of office quarters. Mar. 18, 1901, a bill was introduced in the assembly repealing ch. 355 of the laws of 1883, giving to the board of regents the supervision and control of such rooms in the State hall as were then or were to be occupied by the state museum. Apparent necessity for this legislation arose from the demand for room on the part of the state controller, the work of whose department had in certain directions become greatly enlarged by recent legislation. Before this bill passed the legislature, as it eventually did, provision was made in the supply bill to move the offices of the paleontologist and his staff to the second floor of the Geological hall. The items for this expense did not however meet the approval of the governor. Though we were thus left undisturbed, I desire to record here the fact that, at the time this proposition to remove our quarters was made, we occupied offices in the State hall with a floor space of 6822 square feet, divided among six rooms on the third floor and two rooms in the basement. Of the third floor rooms three of the largest were unsuited for any other purpose than storage on account of insufficient light. These with all the rest were filled with stacks of drawers containing the synoptic and special collections of the department. It was calculated at the time that the actual weight of the paleontologic specimens in this building, together with all movable furnishings and appurtenances of the department, was more than 250 tons. The failure of the appropriation referred to did not lessen the controller's need for more room; and, as the legis-

lative bill relieving the regents from the control of these rooms passed with the executive approval, we were soon thereafter called on to surrender as much space as possible for that purpose.

In previous reports I have repeatedly referred to the fact of the embarrassment to our work arising from the insufficiency of space to render our material, specially the recent acquisitions accruing from field work in actual operation, accessible for study. It has been a source of constantly increasing difficulty to adjust ourselves to these restricted and hampering conditions. However, in response to the controller's wishes, we have sacrificed 2000 square feet of floor space, including two of the three well lighted rooms, and, with all our effects in the contracted space remaining, are endeavoring to carry forward our work and to find place for our constantly growing collections.

The accessions accruing annually from necessary field operations are large, as these reports indicate; and the proposition to return to Geological hall, after having left it 20 years ago because the building was then regarded as overcrowded, involves a serious step backward. It is needless for me, under these oppressive surroundings, to renew a plea for appropriate quarters. The condition itself is an acute appeal therefor. Such quarters will come only with the construction of a modern and suitably equipped building for the museum, and this condition seems to be fully appreciated by all the friends of the institution.

Exhibit of the department at the Pan-American exposition. The department was called on to prepare an exhibit for the exposition at Buffalo. In response to this request an effort was made to bring together:

1 A series of the publications of the state relating to paleontology and stratigraphy.

2 The geologic maps issued by the department on the topographic quadrangles.

3 A series of the original drawings and plates of lithographs used in these publications.

4 Certain suites of fossils which it was thought could be displayed to best advantage with the least risk and would appeal best to the visiting public.

In addition thereto, there was prepared for this occasion an illustrated guide to the geology and paleontology of the Niagara falls and gorge.

With the cooperation of the Buffalo society of natural sciences, I brought together an extensive series of the remarkable crustaceans (Eurypterus, Ptergotus, Eusarcus, Erettopterus, Ceratiocaris) which are found in the waterlimes occurring at the well known cement quarries at Buffalo; and it is safe to say that no such collection of these remarkable and interesting objects was ever before brought together in one place. Great credit and much gratitude are due to the generosity of the Buffalo society in allowing their material from these rocks to be exhibited with that of the state museum in the completion of this series.

As a second exhibit of this kind, an extensive collection was prepared, to represent the fossil glass sponges which were the subject of a recently published state museum memoir. Here again we are placed under many obligations by the great consideration of E. B. Hall of Wellsville, the owner of a large number of characteristic and beautiful specimens of these fossils, which we supplemented in a measure with material from the state museum.

In the preparation of the guide to the geology and paleontology of Niagara falls and vicinity, we again had the cooperation of the Buffalo society of natural sciences. This work was placed in charge of Prof. A. W. Grabau, who made a special resurvey of the region and some special collections of fossils. The work was designed to treat of the origin of Niagara falls, its history and development, and incidentally the development of the topography of the adjoining region; a considerable part of the work was devoted to the stratigraphy and the character of the fossils, with abundant illustrations of all the species known to occur in the exposures along the gorge. As a whole the guide seemed well adapted

to the requirements of teachers, students and tourists generally; and the general demand for it is sufficient testimony of its usefulness. I am gratified to add that the exhibit of the department received the highest award, a gold medal.

Memorial tablet for the Emmons house, Albany N. Y.

It seems appropriate to take note here of the recent action of the American association for the advancement of science at its Denver meeting, August 1901, authorizing the placing of a bronze tablet on the house which formerly was the home of Dr Ebenezer Emmons, state geologist of New York in charge of the second geological district, 1836-42, to commemorate the fact that the association looks on this house as the place of its inception. The events leading up to this action are rehearsed in the following document, which is the report and recommendation made by the committee of the American association for the advancement of science, and adopted by that body.

Report of committee of American association for the advancement of science on the Emmons house memorial

The American association for the advancement of science was organized in 1847. It was the organic descendant and enlarged outgrowth from the Association of American geologists and naturalists. The latter body was created in 1842 by the incorporation of the naturalists within the Association of American geologists. The Association of American geologists is therefore to be looked upon as the legitimate organic ancestor of the American association for the advancement of science.

The circumstances which led up to the organization of the Association of American geologists are as follows:

During the prosecution of the geological survey of the state of New York the need of the geologists for consultation and interchange of view with others engaged in official geologic work led to the suggestion of an organization of a body of American geologists.

It appears that Lieut. W. W. Mather, one of the New York geologists, suggested the subject of such a meeting to the board of geologists in November 1838. He wrote:

" Would it not be well to suggest the propriety of a meeting of the geologists and other scientific men of our country at some central point next fall, say in New York or Philadelphia? There are many questions in our geology that will receive new light from friendly discussion and the combined observation of

various individuals who have noted them in different parts of our country. Such a meeting has been suggested by Prof. Hitchcock, and to me it seems desirable. It would undoubtedly be an advantage not only to science but to the several surveys that are now in progress and that may in future be organized. It would tend to make known our scientific men to each other personally, give them more confidence in each other and cause them to concentrate their observations on those questions that are of interest either in a scientific or economical point of view. More questions may be satisfactorily settled in a day by oral discussion in such a body than in a year by writing and publication." (Letter from W. W. Mather to the geological board of New York, dated Nov. 9, 1838, and addressed to Prof. Emmons)

It appears herein that the suggestion of this meeting was originally made by Pres. Edward Hitchcock of Massachusetts, who was the first to receive the appointment as geologist of the first district of New York from Gov. Marcy. Pres. Hitchcock has said in regard to the suggestion made by Lieut. Mather: "As to the credit he has here given me of having previously suggested the subject, I can only say that I had been in the habit for several years of making this meeting of scientific men a sort of hobby in my correspondence with such."[1]

Lieut. Mather's letter to the board of geologists was taken up for consideration at a meeting held Nov. 20, 1838, at the house of Dr Ebenezer Emmons, corner of High st. and Hudson av., Albany.[2]

The action taken by the geologists was one of unanimous approval of the proposition, and Lardner Vanuxem of the third district was commissioned to open communication with other geologists, specially with Pres. Hitchcock, with reference to carrying this project into effect. The undertaking was not immediately successful, and at a meeting held in the autumn of 1839 the purpose of the geological board was reiterated. This meeting was also held at Dr Emmons's house, the four geologists and the paleontologist being present, and also Ebenezer Emmons jr, who still survives. As a result of the second undertaking on the part of the New York geologists, a meeting was called in Philadelphia for April 1840, where and when the organization of the Association of American geologists was effected. The following year the association again met in Philadelphia, when the membership of the body was largely increased,

[1]Address of Pres. Edward Hitchcock at the inauguration of Geological hall at Albany, Aug. 27, 1856. N. Y. state cabinet of natural history. 10th an. rep't. 1857. p. 23.

[2]*See* documents hereto appended, being A, a statement dictated by Prof. James Hall, Aug. 24, 1806, and B, a statement dictated by Ebenezer Emmons jr February 1900.

and in 1842 the place of meeting was Boston, and then, as already rehearsed, both the name and scope of the association were, at the solicitation of the naturalists, enlarged. Pres. Hitchcock, addressing the New York public interested in the outcome of the work of their geologists, makes the following statement in the address already quoted:

"It may be thought that the New York geologists in their invitation and the members of that first Philadelphia meeting had no thought of extending their association beyond geologists; but Prof. Mather's language just quoted speaks of 'a meeting of the geologists and other scientific men of our country', thus showing what were his aspirations, and they were shared by all of us who had anything to do with that first meeting. But we knew that only a short time previous the American academy of arts and sciences at Boston had directed a request to the American philosophical society as the oldest of the kind in the country, that it would invite the scientific men of the land to such a meeting as the one we are now enjoying; but the distinguished men of that society declined through fear that the effort would prove a failure. Surely then it did not become us to announce any such intentions or expectations; yet we did talk of them and could not but hope that what might fail if attempted on a large scale at first might be accomplished step by step. *Had not the New York geologists issued that modest invitation and confined it at first to the state surveyors, probably even yet we might have been without an Association for the advancement of science.*"[1]

The committee appointed by this association to consider the matter of placing a memorial tablet on the Emmons house in Albany N. Y. begs to submit the foregoing as evidence of the prenatal history of the American association and to recommend that this house, the home of the late Ebenezer Emmons, a man of eminence in his profession, of untiring diligence and enduring patience, be permanently marked by a tablet setting forth the interest of that spot to the history of the association. It is suggested that such tablet bear the following inscription:

IN THIS HOUSE, THE HOME OF
DR EBENEZER EMMONS,
THE FIRST FORMAL EFFORTS WERE MADE, IN
1838 AND 1839, TOWARD THE ORGANIZATION OF THE
ASSOCIATION OF AMERICAN GEOLOGISTS,
THE PARENT BODY OF THE
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,
BY WHOSE AUTHORITY THIS TABLET IS ERECTED.
1901

[1] Address of Pres. Edward Hitchcock, as cited.

The committee further reports that the cost of this tablet will constitute no claim on the treasury of the association but will be borne individually by one of its members, Dr T. Guilford Smith.

Signed by { JOHN M. CLARKE, *Chairman*
C. H. HITCHCOCK
J. McK. CATTELL
W. J. McGEE

A. Statement dictated to John M. Clarke by Prof. James Hall, Aug. 24, 1896.

The organization of a body of American geologists was proposed by the four geologists at Dr Emmons's house at the corner of Hudson av. and High st. It was during the fall of 1838. Vanuxem was asked to see or communicate with the Rogerses concerning it, but nothing came of it that year. The next year we reiterated our purpose, as the intention was to get some means of comparing our results with those of other geologists in other states, especially in Pennsylvania. This meeting was held at Dr Emmons's house, the four geologists being present and perhaps also Conrad. Ebenezer Emmons jr was also there. We then decided to communicate again with the Rogerses and others for the end already suggested and to organize a society of geologists for this especial purpose. We wanted to compare our results with those of others and make up our nomenclature, and we had to do it soon as we were required to publish. As a result of this unanimously expressed purpose, a meeting was called for April 1840 in Philadelphia. I was present then but not at the second Philadelphia meeting in 1841, as that year I was off in May and June with D. D. Owen on a flatboat sailing down the Ohio, sleeping on a box and collecting fossils all along from Louisville to New Harmony. As far as Rogers was concerned the meeting came to naught. He was not ready with his results and gave them only at the third meeting at Boston in 1842. It was here that the naturalists proposed to join us, and we agreed thereto, but the Boston meeting was called as the meeting of the Association of American geologists, and in the course of that meeting the name was changed to that of Association of American geologists and naturalists.

B. Statement dictated to John M. Clarke by Ebenezer Emmons jr, February 1900.

I was present at the meeting of the four geologists at my father's house, in 1838. I was then about 16 years old, and had assisted my father in his field work and making drawings

and sketches. Mr Conrad, the paleontologist, was also present. I recollect that the board of geologists then authorized Mr Vanuxem to open correspondence with others for the purpose of effecting an organization.

A bronze tablet measuring 14 by 24 inches has, in pursuance of this action, been placed on the old Emmons house, at the corner of Hudson av. and High st., Albany, and serves to commemorate in some measure the services to American science of the four state geologists of the geological survey of New York (1836-42).

Personnel of office staff

The staff of the office has remained as last year, with the addition to permanent position of D. D. Luther, who has been interruptedly employed in the department since 1891.

Rudolf Ruedemann, assistant paleontologist
D. D. Luther, field assistant
George B. Simpson, draftsman
Philip Ast, lithographer
Jacob Van Deloo, clerk
H. S. Mattimore, preparator and page
Martin Sheehy, machinist

Prof. Charles Butts and C. A. Hartnagel have been employed for parts of the year on special work.

It is with sincere regret that I have to record the death on Oct. 15, 1901, of George B. Simpson, draftsman, after an illness which kept him but a few days from his duties. The loss of Mr Simpson's important services is a serious deprivation to the work of the department.

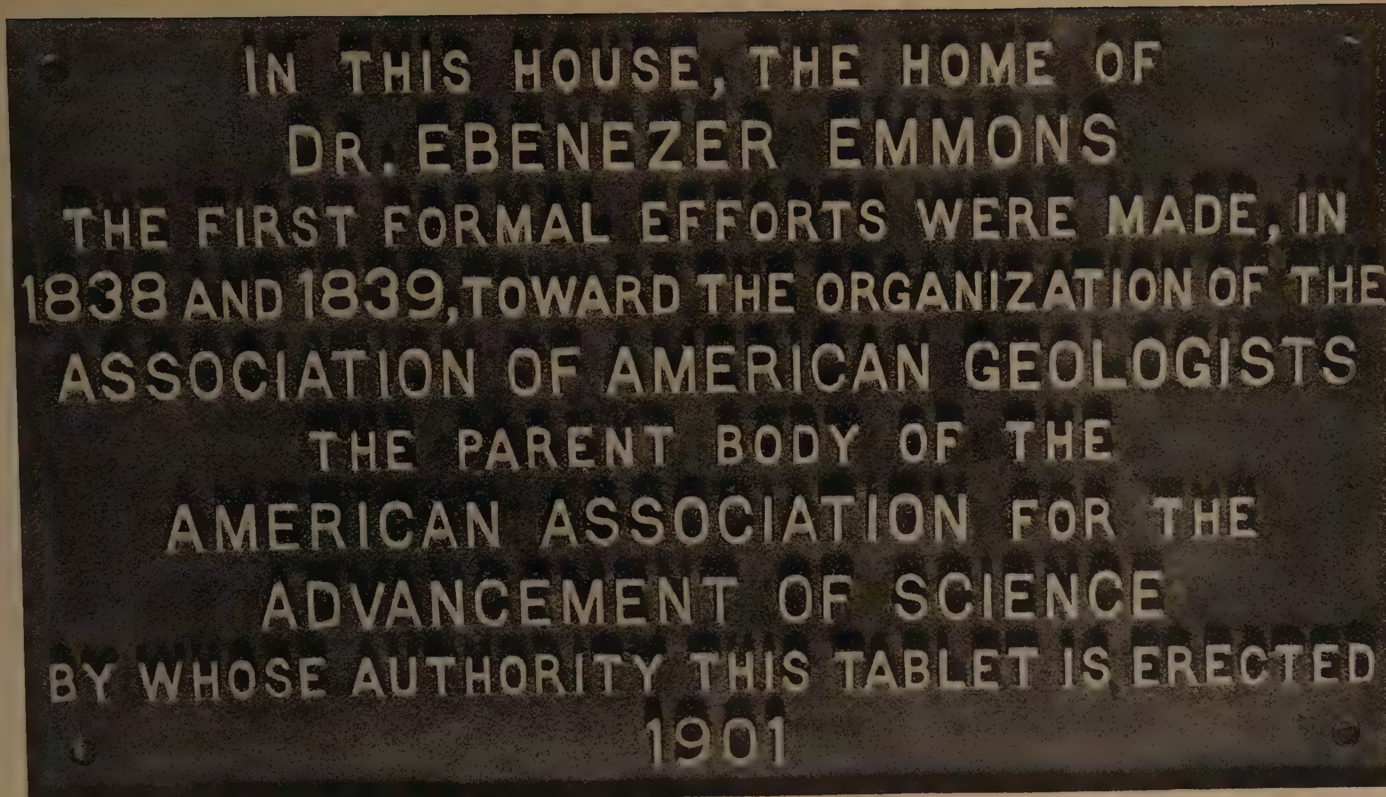
Locality record of museum specimens

In continuation of the record of fossil-producing localities, parts of which have been communicated in my last two reports, I herewith submit a list of the additional localities entered during the course of the last year's work.

21 Oct. 1901 Respectfully submitted

JOHN M. CLARKE
State paleontologist

Plate 1


IN THIS HOUSE, THE HOME OF
DR. EBENEZER EMMONS
THE FIRST FORMAL EFFORTS WERE MADE, IN
1838 AND 1839, TOWARD THE ORGANIZATION OF THE
ASSOCIATION OF AMERICAN GEOLOGISTS
THE PARENT BODY OF THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
BY WHOSE AUTHORITY THIS TABLET IS ERECTED
1901

George Bancroft Simpson

1844-1901

George B. Simpson was born at Boston Mass. Nov. 1, 1844. His father was a mechanical genius and inventor and, though not fortunate in the affairs of this world, was a high-minded man, of upright life and a pillar of the methodist church. His mother was a woman of strong character, genial and lovable disposition. She was the sister of the late Prof. James Hall. Mr Simpson in his young manhood apprenticed himself to a printer, but soon after the breaking out of the civil war, he enlisted for the service, enrolling with Company F, 68th Illinois volunteers, on the 5th of June, 1862. He served with his company for the full term of his enlistment, turning in his bounty and pay to the support of the home, which had then been moved to Waterbury Ct. After his first discharge he came to Albany and was for a brief time employed by Prof. Hall as a collector of fossils, but he soon reenlisted, this time volunteering with the 106th New York infantry, and served therewith till the end of the war. He then entered Yale college, having an ambition for the law, but financial misfortunes fell on the home and were closely followed by the death of the father, so that the cherished hope had to be abandoned, and the young man left college to seek his own and his mother's fortune and to maintain the homestead at Waterbury. He turned to his uncle in Albany, and then, 1868, at the suggestion of Prof. Hall and under the tutelage of the artists who were employed on the paleontologic work of the state, Mr F. H. Swinton and Prof. R. P. Whitfield, he undertook the drawing of fossils for these publications. Here he remained till his death, except for an absence of two years in Pennsylvania, when he was engaged on similar work for the second geological survey of that state.

Mr Simpson's nature was sensitive and retiring, and he was more inclined to shun than seek companionship, so that very few saw the true spirit of the man or realized the motive of his life. Such men, failing to enforce a recognition of their real

merits, pass through life with less than their deserts from their fellows. One whose association with him for many years was close enough to permit him to see within this veil, feels a conviction that the root of every endeavor in this life toward the best ideals, the best execution in daily work, was the love for his mother. In her seemed to be centered all his desire for companionship, for laudation and approval, and for her and the home at Waterbury he provided to the end of her life. From this excellent woman and his good father he seemed to have inherited many fine traits of character, a strict integrity and conscientious punctiliousness and perhaps also his delight in nature and all her works. In his work of preparing scientific drawings of paleontologic objects he succeeded for accuracy of expression and of detail far beyond his own expectation, attaining a power that few have equaled. The thousands of drawings which he made for the *Paleontology of New York* contributed in a most important way to the value and prestige of that work. Less can not be said than that he was the vehicle for the proper expression of our paleontologic data; and many a working paleontologist has allowed himself to express the feeling that a publication, specially of a descriptive character, is less serviceable without the illustrations than the illustrations without the description. On looking at some of his most skilful and elaborate drawings of crustaceans and plants from the Coal Measures, Prof. Lesley, the former state geologist of Pennsylvania, expressed his amazement that such execution was within human power; and yet but few saw the results of Mr Simpson's handiwork save after they had passed through the printing press and were shorn of their finer beauties. Mr Simpson was draftsman less of choice than of necessity. Had his way been clear before him and the preliminary training attainable, his deep seated, never lessening love of nature would have carried him to successful accomplishment in some branch of natural history. The flowers were his constant companions; he seemed to crave their unspoken sympathy, and knew and loved their haunts. When he painted them, it was with a preraphaelite touch that was startling in the exactitude of detail.

This interest in natural history expressed itself in other ways and in much more serious and substantial manner in his published demonstrations of the anatomy of the fresh-water clam (*Anatomy and physiology of Anodonta fluviatilis*, 35th rep't N. Y. state mus. 1884. p. 169-91, pl. 1-11) and in a beautiful and still more elaborate memoir on the anatomy of the snails (*Anatomy and physiology of Polygyra albolabris and Limax maximus and embryology of Limax maximus*, N. Y. state mus. bul. 40) which he did not live to see in published form, but of which almost his last conscious act was to read the proof sheets. One naturally turns first to the illustrations of these papers; and it is worthy of remark that the drawings of this memoir on the snails are the most highly finished that ever came from its author's hands. They were marvels of handiwork and have elicited unstinted praise from expert students of the Mollusca. They have proved, however, beyond the capacity of the printers to reproduce and have hence lost much of their beauty. These works demonstrated Mr Simpson's natural taste for scientific investigation.

In the execution of the various volumes on the *Paleontology of New York*, Prof. Hall planned one on the Bryozoa, a group of lowly molluscoid organisms which abounded in profusion in the old faunas of New York. The drawing of these organisms required great skill and much study, and it naturally followed that the draftsman acquired a close familiarity with this multitude of specific forms, their variations and mutual relations. He became in fact more familiar with them than any one else could become without long and laborious study; and as a consequence Mr Simpson was the virtual author of vol. 6 of the *Paleontology of New York*, which was almost exclusively concerned with these organisms, and not only of this but of all the descriptive matter pertaining to these fossils published during the decade from 1880 to 1890. One outcome of this work was the *Handbook of North American Paleozoic Bryozoa*, published by Mr Simpson, the usefulness of which to many students can not be gainsaid. All these publications on the Bryozoa were substantial contributions to the paleontology of the ancient rocks,

though in certain directions they have been the subject of a criticism whose very rawness has deprived it of force.

The study of the Bryozoa happened, in the plans of Prof. Hall, to be involved with that of the corals; and, as Mr Simpson was called on to make the necessary drawings of these organisms also, and again the execution of the work was dependent on the correct representation of fine internal, structural characters, the artist acquired a detailed knowledge also of these obscure characters. Mr Simpson supplied all descriptive matter pertaining to the corals published from 1880 to 1890. For some time before the death of Prof. Hall material was being gathered and studied for a more comprehensive memoir on the genera and species of the extinct corals; and on the drawings and descriptive part of this work Mr Simpson labored faithfully to within a few months of his death. Thus in this field too we shall find ourselves owing much to his fine powers of observation.

Mr Simpson married in 1891 Miss Abigail L. Soule, who survives him.

J. M. C.

APPENDIX 1

ACCESSIONS

The additions to the paleontologic collections have been by donation, purchase, exchange and collection. A detailed statement of these acquisitions is given herewith.

Donations

Judson, W. P., Albany		
Trilobite from the Trenton limestone, Chaumont.	1	
Fossils from the Onondaga limestone, bottom of Lake Erie.	2	
Luther, D. D., Naples		
Triarthrus from the Utica slate near Rome.	50	
Walcott, C. D., U. S. national museum		
Specimens of Beltina danai Walc. Belt series (pre-Cambric) Glenwood and Neihart Mont.	25	
Derby, O. A., Sao Paulo, Brazil		
Nothothyris ? smithi Derby. Middle Devonic, Matto Grosso, Brazil.	3	
Bennett, L. J., Buffalo		
Pterygotus and Eurypterus. Waterlime, Buffalo.	3	
Wilson, J. D., Syracuse		
Thoracoceras wilsoni Clarke. Agoniatites limestone, Manlius.	4	(4 types)
Swartz, C. K., Bellevue O.		
Fossils from Onondaga limestone. Stafford.	2	
Loomis, F. B., Amherst Mass.		
Fossils from Clinton limestone: Peronosporites ramosus Loomis; P. globosus Loomis; P. minutus Loomis	4	(4 types)

Calvin, Samuel, Iowa City Ia.		
Devonic fossils, Lime Creek and Independence Ia.	150	
Letson, Elizabeth J., Buffalo		
Pleistocene shells from Niagara river, illustrated in museum bulletin 45.	40	(33 hypotypes)
Dolph, J. M., Port Jervis		
Pleurotomaria sulcomarginata var. Hamilton beds, Port Jervis.	1	
The paleontologist		
A collection of fossils from various New York localities of the Helderberg and Onondaga limestones, the Marcellus shales, Hamilton, Genesee, Naples, Oneonta and Chemung beds; together with specimens of minerals (200) and Indian relics (450).	5 296	
This collection includes the following type specimens:		
Crustacea (Hamilton)		3
Goniatites (Genesee and Naples)		125
Lamellibranchs (Genesee and Naples)		116
Miscellaneous (Naples)		6
Miscellaneous (Genesee)		18
		268
Hall, E. B., Wellsville		
Chemung fossils from Broome co.	40	
Davis, E. E., Norwich		
Fossils from the Ithaca formation near Norwich and Coventry.	15	
Psaronius. Large specimen from Oneonta sandstone, Oxford.	1	
Chadwick, G. H., Catskill		
Paropsonema cryptophya, from Naples beds, Hicks's gully, Canandaigua lake.	1	

Fossils from Oneonta shales near Lawrence station, Greene co.	10	
Wood, Elvira, Waltham Mass.		
Fossils from the Stafford limestone, Lancaster, Erie co.		
Carnia recta Wood	1	(1 type)
Ambocoelia nana ?Grabau	1	(1 type)
Gordon, Robert H., Cumberland Md.		
Goniatites from the Marcellus shales at Cumberland and Corrigansville Md.	17	
Clark, W. B.,		
Fossils from the Jennings formation, western Maryland.	1bbl.	
Total by donation	5 667+1bbl.	(278 types; 33 hypotypes)

Purchases

The S. W. Ford collection of Cambric fossils:		
Palaeophycus incipiens Bill., Troy	2	
Archaeocyathus rarus Ford, Troy	1	(1 type)
A. rensselaericus Ford, Troy	1	(1 type)
Ethmophyllum ? (cast), Troy	1	
Lingulella caelata Hall, Troy	36	(3 hypotypes)
Obolella crassa Hall, Troy	46	(6 hypotypes)
Obolella crassa Hall, Lansingburg	1	
O. gemma Bill., Troy	6	(3 hypotypes)
O. nitida Ford, Troy (6 specimens missing)		
O. nitida ? Ford, Lansingburg	1	
Kutorgina labradorica Bill., Swanton Vt.	7	(4 hypotypes)

Billingsella festinata Bill., Swanton Vt.	1	
Scenella retusa Ford, Troy	1	(1 type)
Stenotheca rugosa Hall, Troy	9	
Stenotheca rugosa Hall, Lansingburg	1	
Hyolithus (sp.), Troy	1	
H. americanus Bill., Troy	29	
H. communis var. emmonsi Ford, Troy	14	(2 types)
H. impar Ford, Troy	15	(3 types)
H. micans Bill., Troy	38	
Fordilla troyensis Barr., Troy	5	(5 hypotypes)
Aristozoe troyensis Ford, Troy	1	(1 type)
Bathyurus senectus Bill., Bic harbor Can.	2	
Microdiscus speciosus Ford, Troy	60	(3 types)
Microdiscus speciosus Ford, Lansingburg	1	
M. meeki Ford, Troy	1	(1 type)
M. lobatus Hall, Troy	7	
M. punctatus ? Salter, St John N. B.	1	
M. (sp.), Bic Harbor Can.	2	
Olenellus asaphoides Em., Troy	80	(12 hypotypes)
O. asaphoides Em., Bald mountain	3	
O. asaphoides Em., Lansingburg	5	
O. vermontana Hall, Parker's farm, Vt.	1	
O. thompsoni Hall, L'Anse-au-Loup Can.	1	
Ptychoparia teucer Bill., ½ mile east of Swanton Vt.	1	

P. teucer Bill., Highgate Vt.	1	
P. saratogensis Walc., Poughkeepsie	4	
Conocoryphe trilineata Em., Reynold's Inn, Washington co.	1	(1 plastotype)
Conocoryphe trilineata Em., Troy	17	(2 hypotypes)
Solenopleura nana Ford, Troy	10	(1 type)
Solenopleura nana Ford, Lansingburg	1	(1 hypotype)
(Missing, specimens of Obolella nitida Ford, including 1 type and type of Agnostus nobilis Ford, reported lost by Mr Ford)		
Total specimens 416		
types 14		
hypotypes 36		
plastotypes 1		
Ward & Co., Rochester		
Trenton fossils	4	
Waterlime fossils	1	
Camarocrinus, Helderbergian Cumberland Md.	5	
Total by purchase	426	(14 types; 36 hypotypes)

Exchanges

Crandall, A. R., Alfred		
Pephricaris horripilata Clarke.	1	(1 type)
Cincinnati society natural history, through Dr Josua Lindahl		
Phragmodictya catilliformis. Keokuk beds, Crawfordsville Ind.	1	

Judson, W. P., Albany		
Amphigenia elongata. Bottom of Lake Erie at Buffalo.	1	
Cushing, H. P., Cleveland O.		
Type specimens from the collection of Prof. S. G. Williams deceased, formerly of Cornell university, Ithaca:		
Nautilus (Discites) inopinatus Hall. Onondaga limestone, Kelleys Island O.	1	(1 type)
Orthoceras caelamon Hall. Hamilton shales, Moravia	2	(2 types)
O. lima Hall. Hamilton shales, Cazenovia	1	(1 type)
Gomphoceras pingue Hall. Hamilton shales, north of Cazenovia	1	(1 type)
Orthoceras pertextum Hall. Ithaca beds, Cornell-Fiske quarry, Ithaca	1	(1 type)
O. bebryx var. *cayuga* Hall. Ithaca beds, Earl's quarry, Ithaca	2	(2 types)
O. bebryx var. *cayuga* Hall. Ithaca beds, University quarry, Ithaca	4	(4 types)
O. bebryx var. *cayuga*, Cascadilla ravine, Ithaca	1	(1 type)
Manticoceras sinuosus Hall. Ithaca beds, University quarry, Ithaca	2	(2 hypotypes)
Orthoceras anguis Hall. Ithaca beds, Cascadilla creek, Ithaca	3	(1 type)
O. fulgidum Hall. Ithaca beds, Cascadilla creek, Ithaca	1	(1 type)

O. demus Hall. Ithaca beds, Cascadilla quarry, Ithaca	1	(1 type)
Gomphoceras tumidum Hall. Ithaca beds, Cascadilla quarry, Ithaca	1	(1 type)
Total by exchange	24	(18 types; 2 hypotypes)

Collections

The paleontologist		
Crustacea from the black shales at base of the Salina, 1½ miles northwest of Pittsford	19	
The paleontologist and Luther, D. D.		
Fossils from the Guelph dolomites at Galt, Hespeler and Elora Ont.	225	
Ruedemann, Rudolf		
Graptolites from the Beekmantown horizon, Melrose	1 420+1bbl.	
Fossils from the Agoniatite limestone, Cox's ravine, Cherry Valley	100	
Luther, D. D.		
Fossils from the Ithaca beds, Killawog, Lisle and vicinity	300	
Crustaceans from the Waterlime beds at Wheelock's farm, Litchfield	90	
Fossils from the upper Ithaca and Chemung rocks, Greene	70	
Fossils from the Portage rocks of Naples and the Salina shales near Pittsford	75	
Guelph fossils from canal feeder, 2 miles south of Shelby	60	
Laforge, Laurence		
Niagara fossils from Middleport	300	
Butts, Charles		
Remainder of fossils from the Chemung and Carbonic rocks of Olean sheet, 1900	2 400	

Fossils from the higher Devonic and lower Carbonic strata at localities situated on the Salamanca topographic sheet	800
Hartnagel, C. A. and **Mattimore, H. S.**	
Ithaca fossils from sections in Tompkins co.	1 140
van Ingen, Gilbert	
Fossils from the Potsdam and Beekmantown horizons in the Lake Champlain basin	400
Grabau, A. W.	
Fossils from limestone lenses in the Clinton formation at Middleport and Gasport	300
Van Deloo, Jacob	
Euomphalus from the Chemung sandstone near Union, Broome co.	13
Total by collection	7 712+1bbl.
Total accessions	13 829+2bbl. (310 types; 71 hypotypes)

APPENDIX 2

NEW ENTRIES ON GENERAL RECORD OF LOCALITIES OF AMERICAN PALEOZOIC FOSSILS BELONGING TO STATE MUSEUM

ALPHABETIC LIST OF LOCALITIES

Albany (North Albany), (Albany co.), 2565

Alfred (Allegany co.), 2931

Allegany (Cattaraugus co.), 2697, 2700, 2702, 2706, 2708, 2713, 2720, 2723, 2724, 2727, 2728, 2733, 2865

Allen creek (Monroe co.), 3047, 3051

Asbury (Tompkins co.), 2958, 2959

Ausable chasm (Clinton co.), 3031, 3032, 3033, 3034, 3035, 3036, 3037, 3038, 3039, 3040, 3041, 3042, 3045

Avoca (Steuben co.), 2932

NEW YORK LOCALITIES ACCORDING TO COUNTIES

(Names in italic are new to the record.)

Albany co.

Albany
North Albany

Allegany co.

Alfred
Belmont
Belvidere
Bowler station
Ceres
Clarksville
Clarksville Center
Coon hollow
Cuba
Deer creek

Allegany co. (*continued*)

Dodge creek
Friendship
Little Genesee
North Cuba
Van Campens creek
Wellsville
Windfall creek
Wolf creek

Broome co.

Kirkwood
Ouaquaga
Tracy Creek
Union

Cattaraugus co.

Allegany
Barker run
Beehive creek
Bennetts hollow
Birch run
Boardman
Bolivar creek
Bova creek
Bozard hill
Carroll
Carrollton
Cary hollow
Chapin hill
Chipmunk creek
Coopers hill
Dodge creek
Dutch hill
Ellicottville
Fay hollow
Five Mile creek
Four Mile creek
Great Valley
Great Valley creek
Gull brook
Halls
Harrisburg
Haskell creek
Haskell Flats
Hinsdale
Humphrey Center
Hungry hollow
Irish brook
Irvine Mills
Ischua
Ischua creek

Cattaraugus co. (*continued*)

Killbuck
Knapp Creek
Learn hill
Limestone
Limestone brook
Little Valley
Louds creek
McIntosh creek
Mount Hermon
Mount Moriah
Mutton hollow
Newton run
Nine Mile creek
Oil creek
Olean
Oswayo creek
Peth
Portville
Pumpkin hollow
Red House creek
Rice brook
Riverside junction
Rock City
Russell station
Salamanca
Scott
Sugartown
Tuna creek
Tuna Valley
Two Mile creek
Vandalia
Wayman branch
Westons Mills
Wildcat creek
Wildcat hollow

Cattaraugus co. (*continued*)
Wing hollow
Wolf run
Woodchuck hollow

Cayuga co.
Hollow brook
Locke
Moravia

Chemung co.
Elmira

Chenango co.
Burdick
Cowles hill
Flagg gulf
Greene
Juliand hill
Oxford
Pitcher mineral springs ravine
South Otselic
West [Willard's] hill

Clinton co.
Ausable chasm
Beekmantown station
Champlain
Chazy
Coopersville
Corbeau creek
Day point
Kent's falls
Laphams Mills
Mooers
Plattsburg
Schuyler Falls
South Plattsburg

Clinton co. (*continued*)
Valcour station
West Chazy

Columbia co.
Becraft mountain

Dutchess co.
Poughkeepsie

Erie co.
Buffalo
Fox's point
Pontiac
Stony point
West Seneca

Essex co.
Burdick's crossing
Crown Point
Flat Rock point
Port Kent
Ticonderoga
Ticonderoga creek
Willsboro

Franklin co.
Chateaugay

Genesee co.
Stafford

Greene co.
Camp Heart's Content
Lawrence station

Herkimer co.
Dolgeville
Litchfield

Livingston co.
Cashaqua creek
Dansville
Mount Morris

Madison co.
Cazenovia
De Ruyter
Monroe co.
Allen creek
Pittsford
Niagara co.
Lockport
Oneida co.
Trenton Falls
Onondaga co.
Manlius
Spafford
Ontario co.
Bell's gully
Bristol Center
Canandaigua
Centerfield
Cummings crossing
Flint creek
Geneva
Grimes gully (Naples)
Gull berg
Hatch hill
High point
Knapp hill
Lincoln gully
Naples
Parrish gully
West hill
Woodville
Orleans co.
Shelby
Otsego co.
Cherry Valley
Cox's ravine
Otsego co. (*continued*)
Emmons
Laurens
New Lisbon [Noblesville
Rensselaer co.
Bald mountain
Grant Hollow
Lansingburg
Melrose
Troy
Schoharie co.
Schoharie
Schuyler co.
Havana glen
Seneca co.
Lodi falls
Steuben co.
Avoca
Prattsburg
Tompkins co.
Asbury
Buttermilk falls
Cascadilla creek
Esty glen
Fall creek
Forest Home
Glenwood
Groton
Ithaca
Ithaca falls
Ludlowville
McKinney's
Peruville
Portland
Renwick creek
Salmon creek

INDEX TO FORMATIONS

Genesee shale, 2566, 2905, 2906, 2907, 2908, 2925, 2926, 2927, 2928, 2929, 2940, 2941, 2957, 2968, 2981.

Portage beds, 2559, 2957, 2958, 2959, 2962, 2968, 3054.

Sherburne, 2535.

Naples beds, 2909, 2910, 2911, 2912, 2913, 2914, 2915, 2920, 2921, 2922, 2923, 2930, 2939, 2942, 2943, 2944, 3055, 3056.

Wiscoy beds, 2924.

Ithaca beds, 2526, 2527, 2528, 2530, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2560, 2561, 2562, 2563, 2564, 2572, 2573, 2574, 2575, 2576, 2582, 2934, 2955, 2956, 2960, 2961, 2963, 2964, 2965, 2966, 2967, 2968, 2969, 2970, 2971, 2972, 2973, 2974, 2975, 2976, 2978, 2979, 2980, 2981, 3054.

Oneonta, 2938, 2977.

Chemung beds, 2529, 2697, 2705, 2706, 2709, 2710, 2711, 2714, 2715, 2720, 2721, 2723, 2724, 2726, 2727, 2728, 2729, 2733, 2734, 2735, 2737, 2738, 2743, 2748, 2752, 2755, 2756, 2757, 2758, 2759, 2760, 2761, 2762, 2763, 2764, 2765, 2767, 2768, 2770, 2771, 2772, 2773, 2774, 2775, 2776, 2780, 2781, 2782, 2783, 2784, 2785, 2786, 2787, 2788, 2789, 2790, 2791, 2792, 2793, 2794, 2795, 2796, 2797, 2798, 2800, 2801, 2802, 2804, 2805, 2806, 2807, 2808, 2809, 2810, 2811, 2812, 2813, 2814, 2815, 2816, 2818, 2819, 2820, 2821, 2822, 2829, 2833, 2837, 2839, 2842, 2843, 2844, 2845, 2846, 2848, 2849, 2850, 2851, 2852, 2854, 2855, 2856, 2857, 2858, 2859, 2861, 2863, 2864, 2866, 2867, 2868, 2869, 2870, 2871, 2872, 2873, 2874, 2876, 2877, 2878, 2879, 2881, 2882, 2883, 2884, 2885, 2887, 2888, 2889, 2890, 2891, 2892, 2893, 2896, 2916, 2931, 2932, 2933, 2935, 2937, 2946, 2992, 2993, 2994, 2995, 3046, 3049, 3050, 3057, 3060, 3061, 3062, 3063, 3064, 3065, 3066, 3069, 3070, 3072, 3076, 3078, 3081, 3082, 3083, 3084, 3085, 3086, 3087, 3088, 3089, 3090, 3091, 3092, 3093.

Lower Carbonic, 2697, 2698, 2699, 2700, 2701, 2702, 2703, 2704, 2707, 2708, 2712, 2713, 2716, 2717, 2718, 2719, 2722, 2725, 2726, 2729, 2730, 2731, 2732, 2736, 2739, 2740, 2741, 2742, 2744, 2746, 2747, 2749, 2750, 2751, 2753, 2754, 2766, 2769, 2771, 2777, 2778, 2779, 2801, 2803, 2817, 2823, 2824, 2825, 2826, 2827, 2828, 2830,

2831, 2832, 2834, 2835, 2836, 2838, 2840, 2841, 2847, 2853, 2860, 2862, 2865, 2875, 2880, 2894, 2895, 2897, 2898, 2899, 2900, 3058, 3059, 3067, 3068, 3071, 3073, 3074, 3075, 3077, 3079, 3080, 3086.

Coal Measures, 2580.

RECORD OF LOCALITIES

2526 Ithaca beds; upper layers. Quarry on hillside north of Emmons, Otsego co. D. D. Luther, collector. 1900.

2527 Ithaca beds. Cowles hill, Greene, Chenango co. D. D. Luther, collector. 1900.

2528 Ithaca beds. West, or Willard's, hill, ¼ mile west of Greene, and ¼ mile north of Cowles hill. D. D. Luther, collector. 1900.

2529 Chemung beds. Flagg gulf, lower part, Greene. D. D. Luther, collector. 1900.

2530 Ithaca beds. Juliand hill, Greene. D. D. Luther, collector. 1900.

2531 Tully horizon. Laurens, Otsego co.; small ravine west of village. D. D. Luther, collector. 1900.

2532 Tully horizon. 1 mile southwest of New Lisbon [Noblesville], Otsego co. D. D. Luther, collector. 1900.

2533 Ithaca beds. Loose near top of hill southeast of De Ruyter, Madison co. C. S. Prosser, collector. (1895) 1901.

2534 Ithaca beds. 3 miles east of South Otselic, Chenango co., and in glen below the "upper reservoir"; Priest's farm. C. S. Prosser, collector. (1895) 1901.

2535 Ithaca beds (Sherburne). In glen southeast of De Ruyter. C. S. Prosser, collector. (1895) 1901.

2536 Ithaca beds. Lower part of glen east of South Otselic. C. S. Prosser, collector. (1895) 1901.

2537 Ithaca beds. Loose in Havana glen, Schuyler co. C. S. Prosser, collector. (1895) 1901.

2538 Ithaca beds. Shales in lower part of glen east of South Otselic. C. S. Prosser, collector. (1895) 1901.

2539 Ithaca beds. Glen east of South Otselic; above the "lower reservoir." C. S. Prosser, collector. (1895) 1901.

2540 Ithaca beds. Burdick quarry on hill 1½ miles southeast of De Ruyter and 324 feet above the village. C. S. Prosser, collector. (1895) 1901.

2541 Ithaca beds. Lower part of Pitcher mineral springs ravine, Chenango co. C. S. Prosser, collector. (1895) 1901.

2542 Ithaca beds. Shaly sandstone and shales with base of North Norwich fauna, in glen east of South Otselic. C. S. Prosser, collector. (1895) 1901.

2543 Ithaca beds. In glen east of South Otselic from roadside below the "lower reservoir." C. S. Prosser, collector. (1895) 1901.

2544 Ithaca beds. Glen east of South Otselic; Tropidoleptus zone at second bridge. C. S. Prosser, collector. (1895) 1901.

2545 Ithaca beds. On roadside east of Burdick, Chenango co.; Portage barren shales with part of the Sp. mucronatus (Ithaca) fauna. C. S. Prosser, collector. (1895) 1901.

2546 Ithaca beds. Glen east of South Otselic; above Tropidoleptus zone. C. S. Prosser, collector. (1895) 1901.

2547 Ithaca beds. Driscoll's quarry east of State st., Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2548 Ithaca beds. South Cayuga st., Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2549 Ithaca beds. Fowler's quarry south of Ithaca along Delaware, Lackawanna and Western railroad, just beyond 2550. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2550 Ithaca beds. Sheehy's quarry, Ithaca; first quarry south of Ithaca along Delaware, Lackawanna and Western railroad. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2551 Ithaca beds. Foot of Buttermilk falls, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2552 Ithaca beds. Reservoir above Buttermilk falls, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2553 Ithaca beds. Peruville, Tompkins co.; in creek bed and sides of creek just below village. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2554 Ithaca beds. Just below street railway bridge, Cornell hights, Ithaca; horizon slightly higher than 2976. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2555 Ithaca beds. Foot of Triphammer falls, Fall creek, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2556 Ithaca beds. Bates quarry along Delaware, Lackawanna and Western railroad tracks on hill south of Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2557 Ithaca beds. Glenwood, Tompkins co.; along creek ¾ mile from Cayuga lake. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2558 Ithaca beds. Below mill dam, Forest Home, Tompkins co. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2559 Lower Portage beds. 1 mile below Esty glen, Cayuga lake (Tompkins co.), along railroad. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2560 Ithaca beds. South glen at McKinney's, Cayuga lake, 50 yards above 2956. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2561 Ithaca beds. North glen at McKinney's, Cayuga lake; 20 feet above lake. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2562 Ithaca beds. North glen at McKinney's, Cayuga lake; second falls, 130 feet above lake. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2563 Ithaca beds. North glen at McKinney's, Cayuga lake; short distance above 2955. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2564 Ithaca beds. South glen at McKinney's, Cayuga lake, 50 yards above 2960. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2565 Utica horizon. Felt mill, city line (North Albany) Albany. H. S. Mattimore, collector. 1901.

2566 Genesee shale. Right branch of Salmon creek, 2¼ miles northeast of Ludlowville, Tompkins co. 540 feet A. T.

2567 Onondaga limestone. Stafford, Genesee co. C. K. Swartz, donor.

2568 Onondaga limestone. Bottom of Lake Erie at Buffalo. W. P. Judson, donor. 1901.

2569 Onondaga limestone. Kelleys Island O. H. P. Cushing, Cleveland O., exchange. 1901.

2570 Hamilton beds. Moravia, Cayuga co. H. P. Cushing, exchange. 1901.

2571 Hamilton beds. Cazenovia, Madison co. H. P. Cushing, exchange. 1901.

2572 Ithaca beds. Cornell-Fiske quarry, Ithaca. H. P. Cushing, exchange. 1901.

2573 Ithaca beds. Earl's quarry, Ithaca. H. P. Cushing, exchange. 1901.

2574 Ithaca beds. University quarry, Ithaca. H. P. Cushing, exchange. 1901.

2575 Ithaca beds. Cascadilla creek, Ithaca. H. P. Cushing, exchange. 1901.

2576 Ithaca beds. Cascadilla quarry, Ithaca. H. P. Cushing, exchange. 1901.

2577 Waterlime; Eurypterus beds. Buffalo cement co.'s quarry, Buffalo. L. J. Bennett, donor. 1901.

2578 Trenton limestone. Trenton Falls, Oneida co. Ward & Howell purchase. 1901.

2579 Waterlime; Eurypterus beds. Litchfield, Herkimer co. Ward & Howell purchase. 1901.

2580 Lower barren Coal Measures. Carrolton O. J. M. Clarke, donor. 1900.

2581 Algonkian (Belt terrane); Greyson shales. Beltina danai Walc. Near Glenwood and Neihart Mont. U. S. national museum, through C. D. Walcott, donor. 1900.

2582 Ithaca beds; lower strata. Quarry on land of David Wilcox, 225 feet above Tully limestone; ¼ mile south of cemetery, De Ruyter, Madison co. J. M. Clarke, collector. 1895.

2583 Waterlime. Litchfield, Herkimer co.; small outcrop on Alger farm next east of the Wheelock farm. D. D. Luther, collector. 1900.

2584 Helderbergian. Herkimer co. Ward & Howell purchase. 1900.

2585 Niagara limestone. Lockport, Niagara co. Ward & Howell purchase. 1900.

2586 Cambric. Troy, Rensselaer co. S. W. Ford collection, purchased. 1900.

2587 Cambric. Lansingburg, Rensselaer co. S. W. Ford collection, purchased. 1900.

2588 Cambric. Bald mountain, near Lansingburg. S. W. Ford collection, purchased. 1900.

2589 Cambric. Reynold's Inn, Washington co. S. W. Ford collection, purchased. 1900.

2590 Cambric. Poughkeepsie. S. W. Ford collection, purchased. 1900.

2591 Cambric. Near Swanton Vt. S. W. Ford collection, purchased. 1900.

2592 Cambric. Bic Harbor Can. S. W. Ford collection, purchased. 1900.

2593 Cambric. St John N. B. S. W. Ford collection, purchased. 1900.

2594 Cambric. Highgate Vt. S. W. Ford collection, purchased. 1900.

2595 Cambric. Parker's farm Vt. S. W. Ford collection, purchased. 1900.

2596 Cambric. L'Anse-au-Loup Can. S. W. Ford collection, purchased. 1900.

2693 Marcellus (Agoniatite) limestone. Manlius, Onondaga co. John D. Wilson, Syracuse, donor.

2694 Upper Devonic. Hackberry Grove, Lime Creek Ia. Samuel Calvin, donor. 1901.

2695 Upper Devonic. Independence Ia. Samuel Calvin, donor. 1901.

2696 Oriskany beds. Becraft mountain, Columbia co. J. M. Clarke, C. E. Beecher, C. Schuchert and M. Sheehy, collectors.

Fossils collected by Charles Butts in area covered by the Olean quadrangle, Cattaraugus county, 1900. The horizons of this area are numbered as follows, beginning at the top. Locality numbers 2697-2863 inclusive.

1	Arenaceous shales above the Olean conglomerate	15 feet
2	Olean conglomerate	60 feet
3	Interbedded shales and sandstones with *Camarotoechia allegania* Williams	150 feet
4	Impure limestone	4-5 feet
5	Barren shales and sandstones	100 feet
6	Mount Hermon sandstones	10 feet
7	Interbedded red and green shales and flaggy and shaly arenaceous sandstones	220 feet
8	Wolf creek conglomerate	10 feet
9	Green shales and thin bedded arenaceous sandstones	130 feet
10	Chocolate shales and purplish sandstones; upper limit of *Athyris angelica*	100 feet
11	Shales and sandstones	75 feet
12	Shales and arenaceous sandstones with abundance of *Orthothetes chemungensis*	160 feet
13	Cuba sandstone	10–15 feet

Thicknesses as here given are only approximate. Numbers referring to these horizons are recorded with the following entries:

2697 Ravine south from near head of Cary hollow, 2 miles southwest of Allegany, Cattaraugus co. 1675 feet and

1780 feet A. T., no. 9; 1840 feet and 1950 feet A. T. (loose), no. 6 or 8.

2698 Ravine northwest of road between Four Mile and Chipmunk creeks, 1½–3 miles southwest of Allegany. 1700 feet A. T., no. 6.

2699 Northwest side of high hill 1 mile south of road between Four Mile and Chipmunk creeks. 2050 feet A. T. (loose), no. 3.

2700 South side of high hill 4 to 5 miles southwest of Allegany. 2100 feet A. T., no. 3.

2701 Loose near top of hill ¼ mile north of Knapp Creek. 2270–2330 feet A. T., no. 3.

2702 Road just east of Knapp Creek and road from Knapp Creek down Four Mile creek to Allegany. [A 89] 2330 feet A. T., no. 3; [A 90] 2300 feet A. T., no. 3; 2150 feet and 2130 feet A. T., no. 4; 1850 feet A. T., no. 7; 1850 feet A. T. horizon?

2703 Old, washed-out road south of Rock City and just north of New York-Pennsylvania boundary. 1830 feet A. T., no. 7; 1820 feet A. T., no. 7.

2704 Loose; cut from layer of shale in place at summit above conglomerate at Rock City, southwest of Olean. 2360 feet A. T., no. 3.

2705 Old quarry on road between Olean and Five Mile creek, 2 miles northwest of Olean. 1590 feet A. T., no. 10.

2706 Pit on top of hill ¾ mile east of junction of Five Mile, Allegany and Olean roads. 1810 feet A. T., no. 9.

2707 South of Wing hollow, 1 mile west of Five Mile road, Allegany township. 2000 feet A. T. (loose), no. 6.

2708 Eastern spur of high hill at head of Wing hollow, 4 miles northwest of Allegany. 1960 feet and 1710 feet A. T. (loose), no. 6.

2709 Cut in Olean, Rock City and Bradford trolley line, about 2 miles southwest of Olean. 1640 feet A. T., no. 10.

2710 Eastern spur of high hill at head of Wing hollow in angle between Wing hollow and Five Mile road. 1800 feet A. T., no. 9.

2711 Blind road near Olean-Allegany township boundary, 3 miles northwest of Olean. 1880 feet and 1910 feet A. T., no. 9.

2712 Top of ridge between Olean and Bennett's hollow near Olean-Allegany township boundary, 3 miles northwest of Olean. 1930 feet and 2030 feet A. T. (loose), 1965 feet A. T., no. 8.

2713 Near head of southeast branch of Birch run, southwest of Allegany. 1840 feet, 2015–25 feet A. T. (loose), no. 6.

2714 On hillside above trolley road, 2½ miles southwest of Olean. 1600 feet A. T. (loose), no. 9?

2715 ¼ mile east of Erie R. R. depot, Vandalia. 1440 feet A. T., no. 12.

2716 State line by Olean, Rock City and Bradford trolley road. 2300 feet A. T., no. 3.

2717 Loose; trolley road about 4 miles southwest of Olean. 1760–1800 feet A. T., no. 8.

2718 Crest of ridge between Two Mile and Four Mile creeks, about 4 miles southwest of Olean. 1890 feet A. T., no. 7.

2719 Cut on Olean, Rock City and Bradford trolley road between state line and Knapp Creek. 2315 feet A. T., no. 3.

2720 South of road between Four Mile and Chipmunk creeks, 3½ miles southwest of Allegany. 1770 feet A. T., no. 9.

2721 Along Four Mile creek about 4 miles southwest of Olean. 1560 feet A. T., no. 9.

2722 West side of northwest spur of Rock City hill. 1985 feet A. T., no. 6.

2723 Four Mile road near where road to Rock City branches off, 4–5 miles south of Allegany. 1725 feet A. T., no. 9.

2724 Road between Nine Mile and Five Mile creeks, about 5½ miles northwest of Allegany. 1685 feet A. T., no. 11.

2725 1–2 miles northeast of Harrisburg, 3 miles north of New York-Pennsylvania boundary line. 2320 feet A. T., no. 3.

2726 Pumpkin hollow road, ¾, 1, 1½ miles west of Five Mile road, [A 247] 1630 feet A. T., no. 11, [A 247^1] 1760–1800 feet A. T., no. 10, [A 247^2] 1760 feet A. T. (loose), no. 6.

2727 Road over Chapin hill near Allegany-Humphrey boundary about 5–6 miles north of Allegany. 1720 feet A. T., no. 11.

2728 Road over Chapin hill just north of Allegany-Humphrey boundary about 5 miles north of Allegany. [A 248^2] 1800 feet A. T., [A 248^4] 1880 feet A. T., no. 10.

2729 Summit of northeastern spur of Mt Moriah, about 1 mile south of Russell station, Pennsylvania R. R. [A 251^{1-3}] 1630 feet A. T., no. 9, [A 251^4] 1940 feet A. T., no. 7.

2730 West side of Mt Moriah ½ mile south of Russell station on Pennsylvania R. R. 2140 feet A. T., (loose) horizon? [A 252] 2140 feet A. T. loose? [A 252^1] 2120 feet A. T., no. 6.

2731 West side of Mt Moriah. [A 252^2] 2060 feet A. T., no. 7, [A 252^3] 2030 feet A. T., no. 7.

2732 Road forking at state line south of Knapp Creek. 2300 feet A. T. (loose), no. 3.

2733 End of blind road 3½ miles northwest of Allegany. [A 257] 1850 feet A. T. (loose), no. 9,? [A $258^{\&1}$] 2000–1860 feet A. T. (loose), no. 9?

2734 Bed of Van Campen's creek just above railroad bridge, Belvidere, Amity township, Allegany co. 1400 feet A. T. Below Cuba sandstone.

2735 Quarry near Belmont cemetery; loose stone on roadside ½ mile southwest of Belmont. 1470 feet A. T. Below Cuba sandstone.

2736 West of Glenn postoffice, McKean co. Pa. at 2190 feet; road forking. 2100–2190 feet A. T., no. 4?

2737 Ravine 1 mile southwest of Clarksville, Allegany co. west of highway. 1650–1700 feet A. T., no. 12.

2738 Loose near head of ravine on east side of highway about ¼ mile south of Clarksville Center, Allegany co. [Cl. 21] 1650–1800 feet A. T. [Cl. 22] 1770–1795 feet A. T., no. 12.

2739 Loose at head of ravine on east side of highway about ⅓ mile south of Clarksville Center. 2000 feet A. T., no. 7?

2740 Loose east side of Wolf creek near Joel Wixon's farm about 6 miles northeast of Portville. 1800 feet A. T., no. 8. Collection from boulders horizon of conglomerate 50–75 feet higher.

2741 Loose on hillside east of Wolf creek about 1½ miles north of junction with Dodge's creek. 1950 feet A. T., no. 7.

2742 Road ditch near head of Wolf run. 2160 feet A. T., no. 7.

2743 Ravine on hillside ½ mile due north of Clarksville Center. 1710 feet A. T., no. 9.

2744 West side of Wolf creek, steep escarpment west of wide flat in valley bottom 5 miles northeast of Portville. 1890 feet and 1895 feet A. T., no. 8; 2225 feet A. T., no. 3.

2745 Road on Wolf creek about 7 miles northeast of Portville. 1875 feet A. T. (loose), horizon?

2746 Summit of hill, given as 2378 feet on Olean quadrangle, between Wolf creek and Wolf run. 2360 feet A. T., no. 3.

2747 Summit on Cuba-Clarksville road, Clarksville township. 2050 feet A. T. (loose), no. 8.

2748 Roadside cut Cuba-Clarksville road in Clarksville township; also loose on summit of road. 1850 feet A. T., no. 9.

2749 Southwestern part of Clarksville township. 2000 feet A. T., no. 8.

2750 Top of hill about 4 miles nearly due south of Cuba and just south of Cuba-Clarksville boundary. 2122 feet A. T., no. 7.

2751 Bank of creek on Cuba-Clarksville road near third road forking south of Cuba. 2020 feet A. T. (loose), no. 8?

2752 Ravine east of Cuba-Haskell road just south of Cuba-Clarksville boundary. [Cl. 160] and [Cl. 160^2] 1710 feet and 1795 feet A. T., no. 11; [Cl. 160^3] ?, [Cl. 160^{4-8}] 1810-60 feet A. T., no. 10.

2753 Roadside 1 mile south of Cuba-Clarksville boundary. 2050 feet A. T. (boulders), no. 8.

2754 Loose near head of side valley about 1 mile east of Cuba-Clarksville road and 2 miles south of Cuba-Clarksville boundary. 2065 feet A. T., no. 7.

2755 Roadside cut Clarksville-Haskell road ½ mile east of its junction with Haskell road. 1790 feet A. T., no. 11.

2756 Head of ravine by roadside in northwestern corner of Clarksville township. 1755 feet A. T., no. 11.

2757 Armstrong quarry near Erie depot, Cuba. 1555 feet A. T.

2758 Ravine on east side of hill west of road to North Cuba, ½ mile north of Cuba village. 1700 feet A. T., no. 12.

2759 From 2–3 miles east of west county line, about ½ mile north of Cuba-Clarksville boundary. 1960 feet A. T., no. 9.

2760 Ravine 3 miles south of Cuba on road branching from second road to left from Clarksville-Cuba road going south. [Cu 156 $^{1\ \&\ 2}$] 1785, 1760 and 1735 feet A. T., no. 11. [Cu 156 $^{3\ \&\ 4}$] 1855 and 1875 feet A. T., no. 10; [Cu 156^{5}] 1925 feet A. T., no. 9.

2761 Ravine on west side of Cuba-Clarksville road, 3 miles south of Cuba. 1760 feet A. T., no. 11.

2762 Along stream about 3½ miles southwest of Cuba. 1675 feet A. T., no. 11.

2763 Ravine in southwest corner of Cuba township, 3 miles southwest of Cuba. 1705 feet A. T., no. 12.

2764 Creek bank ¼ mile west of Cuba reservoir just west of county line; 1590 feet A. T., no. 13.

2765 Ravine 2 miles southeast of Cuba. 1732 feet A. T., no. 11.

2766 Field in elbow of road 2½ miles southeast of Cuba village; also loose in vicinity of high hill from 1–2 miles north of Cuba-Clarksville boundary. [Cu 185] 1900 feet A. T. (loose), no. 8; [Cu. 186^{1}] 2115 feet A. T., no. 8.

2767 Road up hill from summit between Cuba and Friendship, Allegany co. in southwesterly direction in southern central part of Cuba township. 1790, 1860, 1870 feet A. T., no. 10?

2768 Ravine on west side of valley ¾ mile south of Cuba. 1560, 1570, 1585, 1600, 1635 feet A. T., no. 12; 1750, 1790, 1800 feet A. T., no. 11.

2769 River flats west of Bullis's mill near state line, Eldred township, McKean co. Pa. 1415 feet A. T. (boulders), no. 8. Position?

2770 Road banks Portville-Eldred road ½ mile east of intersection of Louds creek, Eldred township, McKean co. Pa. 1415 feet A. T., no. 9.

2771 Roadside cut on Portville-Eldred road, near river, about 7 miles from Portville in Eldred township, McKean co. Pa. [E 98] 1425 feet A. T., no. 9; [E 98^1] 1425 feet A. T. (loose), no. 8.

2772 Shale bank by roadside 1 mile north of Eldred Pa. near mouth of Indian creek. 1450 feet A. T., no. 9.

2773 Roadside ditch of road southeastern corner of Friendship, Allegany co. between lots 2 and 3. 2075 feet A. T., no. 9?

2774 Ravine entering Ischua valley from northeast, in southeastern corner of Franklinville township. 1750 feet A. T., no. 12.

2775 Road over high hill in southeastern part of Franklinville township; east side. [F 202] 1780 feet A. T., no. 12; [F 202^1] 1995 feet A. T., no. 10; [202^{2-4}] 2030, 2100, 2150 feet A. T., no. 9.

2776 Road running due east and west ⅛ mile north of Humphrey-Franklinville boundary, southeastern part of Franklinville township. 2235 feet A. T., no. 9.

2777 Southeastern corner of Friendship township. 2235 feet A. T., no. 8?

2778 Field on top of high hill in angle formed by roads in middle of southern part of Franklinville township on lot 17, ½ mile north of Franklinville-Humphrey boundary. 2250 feet A. T., no. 8.

2779 Loose; crest of ridge, Rock City, Genesee township, short distance west of rocks. 2310 feet A. T., no. 3.

2780 Roadside cut about 1 mile east of Carroll, Genesee township. 1490, 1500 feet A. T., no. 11.

2781 Cut on Western N. Y. & C. R. R. ½ mile east of Ceres, Genesee township, near Bowler station. 1510 feet A. T., no. 11.

2782 Cut on abandoned railroad at highway crossing at west branch of Windfall creek, about 3 miles north of Little Genesee. 1700 feet A. T., no. 9.

2783 North side of hill between Coon hollow and Deer creek, Genesee township; outcrop in road. 1860 feet A. T., no. 9.

2784 Woodchuck hollow, ¼ mile from intersection with Olean-Hinsdale road. 1460, 1500, 1505 feet A. T., no. 12.

2785 Near mouth of Gull brook about 1 mile west of Hinsdale, also loose in forks of road west of Gull brook. [H 136] 1510, 1520 feet A. T., no. 12; [H 137] 1970 feet A. T. (loose), no. ?

2786 Head of Fay hollow, Hinsdale. 1950 feet A. T., no. 9.

2787 Near summit of Fay hollow about 1 mile north of Pennsylvania R. R. 1525 and 1585 feet A. T., no. 12.

2788 Ravine 50 yards north of Erie depot, Hinsdale, east of railroad track. 1500 feet A. T., no. 12.

2789 Bank of creek in eastern part of Hinsdale township near county line, about 3½ miles northeast of Haskell Flats. 1690 feet A. T., no. 11.

2790 Ravine ½ mile northwest of Haskell Flats, ¼ mile west of junction of roads. 1630 feet A. T., no. 11.

2791 Cut by roadside, road from Scotts Corners eastward to Haskell Flats, Hinsdale township. 1840 feet A. T., no. 9.

2792 Old quarry on hillside just west of Haskell Flats. 1695 feet A. T., no. 10.

2793 Roadside ditch on spur of 2185 feet summit, 3 miles southwest of Cuba. 2045 feet A. T., no. 9.

2794 Top of hill about 2 miles southwest of Cuba. 2045 feet A. T., no. 9.

2795 2170 feet summit west of Oil creek, half way between Cuba and Hinsdale. 2170 feet A. T., no. 9.

2796 Ravine on west side of Oil creek valley about 3 miles northeast of Hinsdale. 1585 feet A. T., no. 12.

2797 Road north and south over 2150 feet summit just south of Hinsdale-Ischua boundary, 1¼ miles east of northwestern corner of Hinsdale township. 2100 feet A. T., no. 9..

2798 Mouth of ravine entering Oil creek on valley from northwest, 3 miles west of Cuba. 1540 feet A. T., no. 12.

2799 Summit of Dutch hill, Hinsdale township. 2235, 2220 feet A. T. (loose). Horizon?

2800 Mouth of ravine entering Ischua valley from northeast ⅔ of a mile north of Scotts Corners. 1555 feet A. T., no. 12.

2801 Roadside 1 mile due north of Humphrey Center. [Hu 206] 1920 feet A. T., no. 8?; [Hu 206^1] 1845 feet A. T. (loose), no. 9?

2802 Hill road from Humphrey Center to Cooper's hill; west side. [Hu 207] 1770 feet A. T., no. 9? [Hu 207^1] 1930 feet A. T., no. 9.

2803 Roadside top of Cooper's hill, northwestern part of Humphrey township; loose. 2225 feet A. T., no. 8?

2804 From head, down to near mouth of ravine entering valley of Five Mile creek from north, just west of Ischua-Humphrey boundary. [Hu 210^1] 1945 feet A. T.; [Hu 210^2] 1870 feet A. T.; [Hu 210^3] 1850 feet A. T., no. 10; [Hu 210^4] 1790 feet A. T.; [Hu 210^5] 1760 feet A. T., no. 11.

2805 Northern end of Ischua township about 2 miles west of south end of Cuba reservoir; also loose top of 2217 feet summit slightly southwest of reservoir. [I 178] 2080, 2130 feet A. T., no. 9; [I 179] 2210 feet A. T., no. 9.

2806 Ravine intersecting Oil creek valley from northwest, 2 miles west of Cuba. 1670 feet A. T., no. 12.

2807 Outcrop by stream 1 mile due east of Ischua depot, south side of valley. 1615 feet A. T., no. 12.

2808 Road running east from Ischua; about 1 mile east of Ischua. 1718, 1800 feet A. T., no. 11.

2809 Road running east from Ischua, from 2-3 miles east of village. 1820 feet A. T., no. 10.

2810 Road running east of Ischua, 1⅓–2 miles east of village. [I 195³⁻⁸] 1935, 1995, 2020, 2030, 2065, 2050 feet A. T.; no. 9.

2811 Ravine running northeast from road 1 mile northwest of Ischua. 1545 feet A. T., no. 12.

2812 Ravine entering Ischua valley from east, 4 miles south of Ischua; ¼ mile up ravine from main road. 1610 feet A. T., no. 12.

2813 Deep gorge running north from road 3 miles southeast of Ischua; 50 yards up gorge. 1860 feet A. T., no. 11.

2814 Near 2015 feet summit, 1 mile north of Hinsdale-Ischua boundary, in Ischua township. 2000 feet A. T., no. 9

2815 Near road 4 miles south of Ischua. 1810 feet A. T., no. 11.

2816 Roadside 4½ miles south of Ischua. 2040 feet A. T., no. 9.

2817 Top of Learn hill, northern part of Ischua township. 2160–2280 feet A. T. (loose), no. 7 or 8.

2818 East bank of Ischua creek, ¼ mile south of Ischua. 1590 feet A. T., no. 13.

2819 Road running near middle of Lyndon township, ¼ mile north of Lyndon-Ischua boundary. 2080 feet A. T., no. 9.

2820 Southwest corner of Lyndon township, just southeast of four corners ½ mile east of Lyndon-Franklinville boundary and 1¼ miles north of Lyndon-Ischua boundary. 2140 feet A. T., no. 11.

2821 Quarry below reservoir about 1 mile south of Olean. 1560 feet A. T., no. 11.

2822 Near brow of steep escarpment facing north; 1¼ miles south of Olean. 1745, 1750, 1760, 1765, 1890, 1900 feet A. T., no. 9.

2823 Old quarry on north slope of Mount Hermon. 1970 feet A. T., no. 7.

2824 Old quarry on west side of Mount Hermon, about 4½ miles south of Olean. 2040 feet A. T., no. 7.

2825 Quarry on west side of Mount Hermon, 1½ miles south of Olean. 2150–2178 feet A. T., no. 6.

2826 Quarry on east side of Mount Hermon. 2150 feet A. T., no. 6.

2827 South slope of Mount Hermon about 3 miles south of Olean. 2100 feet A. T., no. 6.

2828 Cook's quarry, 3–4 miles south of Olean; head of Wildcat hollow. 2000 feet A. T., no. 7.

2829 Old quarry at base of hill on west side of Wildcat creek, 1½ miles southwest of Olean. 1545 feet A. T., no. 12.

2830 Bench on northeast side of hill 2½ miles southwest of Olean. 1960–2025 feet A. T., no. 7.

2831 Road at Four Mile crossing just above the Olean, Rock City & Bradford trolley road. 2200, 2275, 2300 feet A. T., no. 3.

2832 Top of high hill with masses of conglomerate, 3½ miles slightly southwest of Olean. 2300 feet A. T., no. 3.

2833 Quarry in Mount Hermon sandstone, Two Mile valley, 4 miles southwest of Olean. 2090 feet A. T., no. 11.

2834 Cut on old narrow gage railroad from 3–5 miles southwest of Olean; also loose on bank of excavation. 1920–50 feet A. T., no. 7.

2835 3½ miles southwest of Olean. 2125 feet A. T., no. 5.

2836 Cut on abandoned narrow gage railroad between Two Mile and Four Mile valleys, 2½ miles northeast of Rock City. 2160, 2170 feet A. T., no. 4.

2837 Old quarry east of road, and on north side of hill on road from Wayman branch to Olean about 1 or 2 miles southeast of Olean. 1650, 1775, 1875, 1900 feet A. T., no. 9.

2838 Quarry on road from Wayman branch to Olean, 1–3 miles southwest of Olean. 2050 feet A. T., no. 8.

2839 Woods at east of 2240 feet hill, ½ mile south of Wayman branch, 4 or 5 miles southeast of Olean. 1750 feet A. T., no. 9.

2840 Near top of 2240 feet summit, southeast corner of Olean township. 2175 feet A. T., no. 3.

2841 West side of Mount Hermon by road leading to quarry at top, 1½ miles south of Olean. 1940 feet A. T., no. 7.

2842 Quarry about 1¼ miles south of Olean in ravine on east side of Wildcat hollow road. 1560 feet A. T., no. 11.

2843 Escarpment of spur above quarry ½ mile northwest of Olean. 1680 feet A. T., no. 10; 1745 feet A. T., no. 9.

2844 Mouth of ravine ½ mile north of oil refineries, Olean. 1500 feet A. T., no. 11.

2845 On Western N. Y. & Pa. R. R. (Bradford division) 4 miles southwest of Olean. 1750, 1850 feet A. T., no 9.

2846 Cut on Pennsylvania R. R. near United pipe line pumping station, Olean. 1450 feet A. T., no. 12.

2847 Near mouth of Louds creek near New York-Pennsylvania boundary. 1480 feet A. T. (loose), no. 8?

2848 Outcrops at spring by roadside 2½ miles northwest of Olean. 1640 feet A. T., no. 10.

2849 Old quarry on hillside west of Olean-Hinsdale road just south of Woodchuck hollow. 1670 feet A. T., no. 10.

2850 Old quarry on second road west from Olean. 1670 feet A. T., no. 10.

2851 Quarry ½ mile northwest of Erie depot, Olean. 1650 feet A. T., no. 10.

2852 Bank of Dodges creek just above bridge on northeastern outskirts of Portville. 1445, 1480 feet A. T., no. 11.

2853 Loose; top of bench on north side of 2224 foot hill 1 mile west of Portville. 2050 feet A. T., no. 3.

2854 West side of Wolf run opposite 2378 foot summit. [P 72] 1620 feet A. T., No. 11.

2855 North bank of Haskell creek about 3 miles northeast of Boardman. 1600 feet A. T., no. 11.

2856 Roadside cut on summit between Boardman and Haskell creek. 1750 feet A. T., no. 9.

2857 South bank of Allegany river at Weston Mills, opposite Riverhurst park. 1420 feet A. T., no. 11.

2858 Just west of Haskell creek, opposite junction of Wolf run. 1550 feet A. T., no. 11.

2859 Outcrop in field by road to Wayman branch ½ mile southwest of bridge at Portville. 1500 feet A. T., no. 11.

2860 Loose; south of first summit of ridge south of bridge across the Allegany river at Portville. No. 7.

2861 Cut on Pennsylvania R. R. near bridge over Oswayo creek ¼ mile south of Portville. 1435 feet A. T., no. 11.

2862 Loose in field north of Carrollton. 1470 feet A. T., no. 8.

2863 Road on south bank of Allegany river in southwest outskirts of Portville. 1450 feet A. T. (loose), no. 11?

2864 Near head of west branch of Gull brook, 3 miles southwest of Ischua. 1890 feet A. T., no. 11.

2865 Loose; south spur of 2100 feet hill about 2½ miles northwest of Allegany. 1910, 1960 feet A. T., no. 7.

2866 Quarry on east side of Cuba reservoir near dam. 1595 feet A. T., no. 13.

2867 Roadside, bank of Indian creek, Eldred, McKean co. Pa. 3–4 miles south of state line. 1540 feet A. T., no. 9.

2868 Roadcut 100 rods north of Bowler station on Central New York and Western R. R. Genesee township. 1560, 1600 feet A. T., no. 11.

2869 From block of hard sandstone firmly embedded in road and ditch, 2 miles south of Little Genesee. 1850 feet A. T., no. 9?

2870 Road on top of hill 1 mile east of Hinsdale. 1980 feet A. T., no. 9.

2871 Road ditch on boundary between Ischua and Hinsdale in northwestern corner of northern jog of Hinsdale. 2020 feet A. T., no. 9.

2872 Ravine on west side of valley ½ mile south of Cuba. 1600 feet A. T., no. 12.

2873 Roadcut at northeast of Dutch hill in northwestern corner of Hinsdale township. 1810 feet A. T., no. 10.

2874 Outcrop of sandstone ⅓ mile northeast of Ischua depot near road forking. 1610 feet A. T., no. 12.

Locality numbers 2875–2900 and 3057–3094 represent fossils collected by Charles Butts during 1901 in area covered by the

Salamanca quadrangle, Cattaraugus co. The horizons of this area are numbered as follows, beginning at the top:

1 Limestone
2 Olean conglomerate
3 Shales and sandstones
4 Salamanca conglomerate
5 Shales and sandstones
6 Wolf creek conglomerate
7 Shales and sandstones
8 Shales and sandstones. Orthothetes zone
9 Cuba sandstone

2875 At angle in road after passing north over hill at head of Newton run, 3½ miles north of Salamanca. Station 313, no. 5.

2876 North side of road from Little Valley creek to Ellicottville near top of hill, ½ mile southwest of Ellicottville. Station 314, no. 7.

2877 Riverside drive 1 mile south of Ellicottville. Station 315, no. 8.

2878 West side of Great Valley creek, about 1½ miles southwest of Great Valley. Station 316, no. 8.

2879 Face of steep bluff west of Great Valley creek, 1½ miles southwest of Great Valley. Station 317 and 317^1, no. 7.

2880 Head of Mutton hollow just north of northern boundary of Salamanca sheet. Station 318, no. 4.

2881 Cut on Buffalo, Rochester and Pittsburg railroad about 2½ miles north of Great Valley. Station 319, no. 7.

2882 Road about ½ mile northeast of Killbuck station. Station 320, no. 7.

2883 Old road over north side of hill, 2–3 miles northeast of Killbuck. Station 321, no. 7.

2884 Head of hollow about 1 mile south of Peth. Station 322, no. 7.

2885 Near mouth of Barker run. Station 323, no. 8.

2886 Collected west of head of Barker run. Station 324, no. ?

2887 Near 2180′ summit, slightly southeast of Sugartown. Stations 325, 325^1, no. 7.

2888 Road west of Five Mile creek and 2–3 miles southwest of Cooper hill. Stations 327, 327^1, no. 7.

2889 Road about ¾ mile south of summit of Cooper hill. Station 328, no. 7.

2890 One mile south of Cooper hill and ¾ mile west of county line, Humphrey township. Station 329, 329^{1-3}, no. 7.

2891 Road ditch on Wrights creek road near head, about ¾ mile northwest of Bozard hill. Station 330, no. 7.

2892 Road about ¾ mile northwest of Humphrey Center. Station 331, no. 7.

2893 Road short distance north of crest of ridge at head of Nine Mile creek. Station 332, no. 7 (loose).

2894 State line on Olean, Rock City and Bradford trolley road. Station 333, 333^{1-4}, no. 2.

2895 In road near head of Limestone brook. Station 334, no. 3; station $334^{1, 2}$, no. 4.

2896 Limestone brook, 2–3 miles west of Limestone. Station 335, no. 7.

2897 Near head of southwest branch of Limestone brook. Station 336, no. 3.

2898 Summit of high hill just north of state line and near boundary between Salamanca and Carrollton townships. Station 337, no. 2.

2899 Near head of east branch of Bolivar creek, Bradford co. Pa. Station 338, no. 2; station 338^2, no. 1.

2900 Trolley cut ⅛ mile west of Knapp Creek. Station 339, no. 2. 20–30 feet below summit at Knapp Creek on road to Four Mile. Station 339^1, no. 3.

For continuation of localities in Salamanca quadrangle area see record numbers 3057–3093.

The following localities from 2901-48 represent material from the collection donated by J. M. Clarke, 1901. On the tickets each of these numbers is preceded by the letter C.

2901 Hamilton shales. Various localities on Canandaigua lake. J. M. Clarke, donor. 1901.

2902 Hamilton shales. Centerfield, Ontario co. J. M. Clarke, donor. 1901.

2903 Marcellus shale. Flint creek, Ontario co. J. M. Clarke, donor. 1901.

2904 Marcellus shale (Stafford limestone). Stafford, Genesee co. J. M. Clarke, donor. 1901.

2905 Genesee shale (Styliola limestone). Canandaigua lake. J. M. Clarke, donor. 1901.

2906 Genesee shale. Bristol Center, Ontario co. J. M. Clarke, donor. 1901.

2907 Genesee shale. Livingston co. J. M. Clarke, donor. 1901.

2908 Genesee shale; base of shales. Bell's gully, Canandaigua lake. J. M. Clarke, donor. 1901.

2909 Naples beds. Various outcrops in the Naples valley. J. M. Clarke, donor. 1901.

2910 Naples beds; goniatite layer. Parrish gully, Naples, Ontario co. J. M. Clarke, donor. 1901.

2911 Naples beds. Mount Morris, Livingston co. J. M. Clarke, donor. 1901.

2912 Naples beds. Cashaqua creek. J. M. Clarke, donor. 1901.

2913 Naples beds. Honeoye lake; mostly young goniatites. J. M. Clarke, donor. 1901.

2914 Naples beds. Conesus lake. J. M. Clarke, donor. 1901.

2915 Naples beds. Rock stream, Yates co. J. M. Clarke, donor. 1901.

2916 Chemung beds. Elmira. Goniatites. J. M. Clarke, donor. 1901.

2917 Middle Devonic (Goniatitenkalk). Bredelar, Westphalia. J. M. Clarke, donor. 1901.

2918 Onondaga limestone. Canandaigua town. J. M. Clarke, donor. 1901.

2919 Helderbergian. Albany co. J. M. Clarke, donor. 1901.

2920 Naples beds; sandstone slabs from upper layers with goniatites. Naples valley. J. M. Clarke, donor. 1901.

2921 Naples beds; lower black band. Cashaqua creek. J. M. Clarke, donor. 1901.

2922 Naples beds; Conodont layer. Base of Hatch hill, Naples. J. M. Clarke, donor. 1901.

2923 Naples beds; upper black band. Sparta town. Cut on D. L. & W. R. R. 6½ miles northwest of Dansville, Livingston co. Fish remains. J. M. Clarke, donor. 1901.

2924 Wiscoy beds. Castile, Wyoming co. J. M. Clarke, donor. 1901.

2925 Genesee shales; bituminous band. Woodville, Ontario co. J. M. Clarke, donor. 1901.

2926 Genesee shales. Various localities on Canandaigua lake. J. M. Clarke, donor. 1901.

2927 Genesee shales. Gull berg, Honeoye lake. J. M. Clarke, donor. 1901.

2928 Genesee shales; upper layers. Yates co. J. M. Clarke, donor. 1901.

2929 Genesee shale (Styliola limestone), Bristol Center, Ontario co. J. M. Clarke, donor. 1901.

2930 Naples beds. Hamilton gully, Honeoye lake. J. M. Clarke, donor. 1901.

2931 Chemung beds. Alfred, Allegany co. J. M. Clarke, donor. 1901.

2932 Chemung beds. Avoca, Steuben co. J. M. Clarke, donor. 1901.

2933 Chemung beds; lower. Prattsburg, Steuben co. J. M. Clarke, donor. 1901.

2934 Outlier of Ithaca beds; third falls of Grimes gully, Naples, Ontario co. J. M. Clarke, donor. 1901.

2935 Chemung beds. Base of High point, Naples. J. M. Clarke, donor. 1901.

2936 Marcellus shales with spores. Canandaigua. J. M. Clarke, donor. 1901.

2937 Chemung beds. Near Wellsville, Allegany co. J. M. Clarke, donor. 1901.

2938 Oneonta sandstone with Amnigenia. Oxford, Chenango co. J. M. Clarke, donor. 1901.

2939 Naples beds. Java Village, Wyoming co. J. M. Clarke, donor. 1901.

2940 Genesee shales; top layer. Lodi Falls, Seneca co. J. M. Clarke, donor. 1901.

2941 Genesee shales (Styliola limestone), Yates co. J. M. Clarke, donor. 1901.

2942 Naples beds. Pontiac, Erie co. J. M. Clarke, donor. 1901.

2943 Naples beds. Fox's point, Lake Erie. J. M. Clarke, donor. 1901.

2944 Naples beds, loose blocks containing Ithaca fossils. Canandaigua lake. J. M. Clarke, donor. 1901.

2945 Marcellus shale. Slate rock falls 4 miles south of Geneva, Ontario co. J. M. Clarke, donor. 1901.

2946 Chemung beds. Canandaigua. J. M. Clarke, donor. 1901.

2947 Utica slate. Dolgeville, Herkimer co. J. M. Clarke, donor. 1901.

2948 Helderbergian. Orange co. J. M. Clarke, donor. 1901.

2949 Helderbergian. Cumberland Md. Ward & Howell purchase. 1901.

2950 Rondout waterlimes. Loose at Canandaigua. J. M. Clarke, collector. 1901.

2951 Hamilton shales. Robertson's quarry, Canandaigua. J. M. Clarke, collector. 1901.

2952 Salina beds. Black shales below green shales. Bottom of Erie canal, 1½ miles northwest of Pittsford, Monroe co. J. M. Clarke, collector. 1901.

2953 Guelph dolomite. Elora Ont. J. M. Clarke, collector. 1901.

2954 Marcellus shales. Canandaigua. J. M. Clarke, collector. 1901.

2955 Ithaca beds. North glen at McKinney's, Cayuga lake. 100 yards above falls. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2956 Ithaca beds. South glen at McKinney's, Cayuga lake. 100 yards above high falls. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2957 Lower Portage beds. ½ mile below Esty glen, Tompkins co. along railroad track. At this place the Genesee is about 12 feet above the lake and contact between Genesee and Portage is well shown, the former capped by a hard blue sandstone 2½ feet thick. C. A. Hartnagel and H. S. Mattimore collectors. 1901.

2958 Lower portage beds. Asbury, below Bower's mill falls, ¼ mile east of Portland. 980 feet A. T. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2959 Lower Portage beds. Asbury, 100 yards below Bower's mill falls, ¼ mile east of Portland. 975 feet A. T. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2960 Ithaca beds. South glen at McKinney's, Cayuga lake. 150 yards above high falls. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2961 Ithaca beds. Right branch of Salmon creek, 3 miles north-northeast of Ludlowville. 540 feet A. T. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2962 Lower Portage beds. First branch of Salmon creek, 1 mile northwest of Ludlowville. 780 feet A. T. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2963 Lower Ithaca beds. Creek bed just east of highway, 1½ miles east of Portland, Cayuga lake. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2964 Ithaca beds. North glen at McKinney's, slightly higher than 2563. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2965 Ithaca beds. South glen at McKinney's, Cayuga lake, above 2564. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2966 Ithaca beds. South glen at McKinney's, Cayuga lake, 50 yards from point where creek divides. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2967 Ithaca beds. Right fork of south glen at McKinney's, where creek divides. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2968 Ithaca beds. Renwick creek, 100 feet above lake; 300 yards from highway at lake. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

This section is not far from the Remington salt works from whose wells the following section was taken:

Portage	240 feet	Onondaga	95 feet
Genesee	125 "	Oriskany	15 "
Tully	30 "	Helderbergian	
Hamilton	1079? "	(waterlimes)	135 "
Marcellus	81? "	Salina	295 "

2137 feet to first salt; total depth 2190 feet.

2969 Ithaca beds. Renwick creek; short distance above 2968. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2970 Ithaca beds. Renwick creek, just above 2969. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2971 Ithaca beds. Foot of Ithaca falls, Fall creek, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2972 Ithaca beds. Top of Ithaca falls, Fall creek, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2973 Ithaca beds. Creek bed foot of cascade at electric light plant, Fall creek, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2974 Ithaca beds. Creek bed just above electric light plant, Fall creek, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2975 Ithaca beds. Foot of first falls above electric light plant, Fall creek, Ithaca. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2976 Ithaca beds. Top of falls above 2975. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2977 Oneonta beds. Camp Heart's Content, below falls, Lawrence station, Greene co. G. H. Chadwick, collector. 1901.

2978 Ithaca beds. Creek bed at Weaver's falls 1 mile northwest of Groton, Tompkins co. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2979 Ithaca beds. 100 yards above 2978. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2980 Ithaca beds. Ben Hatch farm 2½ miles north of Groton. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2981 Ithaca beds. Hollow brook, Locke, Cayuga co. This station is 2 miles southwest of Locke above Genesee shale, which is exposed in lower portion of brook. C. A. Hartnagel and H. S. Mattimore, collectors. 1901.

2982 Beekmantown limestone. Graptolites. Abandoned quarry 1 mile southeast of Melrose and ½ mile east of Grant Hollow, Rensselaer co. R. Ruedemann and H. S. Mattimore, collectors. 1901.

2983 Guelph dolomite. Balantine's quarry east of river, south of railroad station, Galt Ont. Lowest part of Galt section; according to Logan about middle of formation. J. M. Clarke and D. D. Luther, collectors. 1901.

2984 Guelph dolomite. Hogg's quarry west of river; Galt Ont. About same horizon as 2983. J. M. Clarke and D. D. Luther, collectors. 1901.

2985 Guelph dolomite. Mill dam at Galt Ont. Horizon just above 2984. J. M. Clarke and D. D. Luther, collectors. 1901.

2986 Guelph dolomite. Melross's quarry east of river, 1 mile north of Galt Ont. Top of Galt section. J. M. Clarke and D. D. Luther, collectors. 1901.

2987 Guelph dolomite. Hespeler Ont. According to Logan near base of section. J. M. Clarke and D. D. Luther, collectors. 1901.

2988 Guelph dolomite. Webster's quarry, Galt Ont. J. M. Clarke and D. D. Luther, collectors. 1901.

2989*a-r* Cox's ravine, Cherry Valley, Otsego co.

a Marcellus shale in Cox's ravine below falls

b Marcellus shale directly below Anarcestes bed horizon about 10 feet

c Anarcestes bed; limestone bed 1
d Overlying shale
e Limestone bed 2
f Intercalated shale
i Limestone bed 4
k Intercalated shale
l Limestone bed 5
m Intercalated shale
n Limestone bed 6
o Intercalated shale (on Steenburg farm)
p Limestone bed 7 (base on Steenburg farm)
q Limestone bed; middle part
r Limestone bed; upper part

R. Ruedemann, collector. 1901.

2990 Agoniatites limestone. Lamoreaux farm, 1 mile west of Schoharie. R. Ruedemann, collector. 1901.

2991 Marcellus shale. Stony point, West Seneca, Erie co. B. F. Morgan, collector. 1901.

2992 Chemung beds. Near Union, Broome co. J. Van Deloo, collector. 1901.

2993 Chemung beds. Kirkwood, Broome co. E. B. Hall, donor. 1901.

2994 Chemung beds. Near Tracy Creek, Broome co. E. B. Hall, donor. 1901.

2995 Chemung beds. Ouaquaga, Broome co. E. B. Hall, donor. 1901.

2996 Guelph horizon. On canal feeder 2½ miles south of Shelby, Orleans co. D. D. Luther, collector. 1901.

2997 Chazy beds. Roadside 300 feet west of D. & H. R. R. track at Valcour station, Clinton co. G. van Ingen, collector. 1901.

2998 Chazy beds. Ledges in fields to north of normal school, Plattsburg, Clinton co. G. van Ingen, collector. 1901.

2999 Beekmantown limestone. Along D. & H. R. R. tracks in cut near Burdick's crossing, 1½ miles north of Crown Point, Essex co. G. van Ingen, collector. 1901.

3000 Potsdam sandstone. Bed of Saranac river near "Mill D" at Kent Falls, 7½ miles west of Plattsburg, Clinton co. G. van Ingen, collector. 1901.

3001 Potsdam sandstone. Same locality as 3000, but 60 feet higher and 400+ feet farther down the river. G. van Ingen, collector. 1901.

3002 Potsdam sandstone. In bank of Saranac river above "Mill D" at Kent Falls. Horizon is immediately below that of 3001 and 53 feet above that of 3000. G. van Ingen, collector. 1901.

3003 Chazy limestone. Bed of Saranac river just below the "Main mill dam" about 2 miles west of Plattsburg. G. van Ingen, collector. 1901.

3004 Potsdam sandstone in bed of Little Ausable river at Schuyler Falls, Clinton co. G. van Ingen, collector. 1901.

3005 Chazy limestone at east side of West Chazy to Chazy road, 1½ miles northeast of West Chazy station, Clinton co. G. van Ingen, collector. 1901.

3006 Potsdam-Beekmantown transition beds on road from Champlain to Chazy, west road (westerly of the two south bound roads), at top of hill about 2 miles south of Champlain, Clinton co. G. van Ingen, collector. 1901.

3007 Potsdam sandstone at bridge over Carbeau creek at three corners, ¾ mile west of Coopersville, Clinton co. G. van Ingen, collector. 1901.

3008 Potsdam sandstone in fields on Champlain to Chazy east road about ¾ mile north of the four corners west of Cooperville, Clinton co. G. van Ingen, collector. 1901.

3009 Potsdam-Beekmantown transition beds on Champlain to Chazy east road, 2 miles south of Champlain. G. van Ingen, collector. 1901.

3010 Potsdam-Beekmantown transition beds on Champlain to Chazy east road, 2 miles south of Champlain. Horizon 4 feet above that of 3009. G. van Ingen, collector. 1901.

3011 Potsdam-Beekmantown transition beds on Champlain to Chazy east road, 1½ miles south of Champlain. G. van Ingen, collector. 1901.

3012 Potsdam-Beekmantown transition beds on Champlain to Chazy east road, 1½ miles south of Champlain. Horizon 21 feet above that of 3011. G. van Ingen, collector. 1901.

3013 Beekmantown beds in Marble river at Hill's sawmill, 1 mile above junction of Marble and Chateaugay rivers, 2 miles north of Chateaugay, Franklin co. G. van Ingen, collector. 1901.

3014 Potsdam sandstone in Marble river near Pat Welch's, 1 mile north of Chateaugay, Franklin co. G. van Ingen, collector. 1901.

3015 Potsdam-Beekmantown transition beds in bed of Ticonderoga creek just below the second pulp mill above the village of Ticonderoga, Essex co. G. van Ingen, collector. 1901.

3016 Potsdam-Beekmantown transition beds along shore of Lake Champlain on west side of Mt Independence near A. A. Blood's house, in town of Orwell, Addison co. Vt. G. van Ingen, collector. 1901.

3017 Beekmantown beds in bed of Boquet river in village of Willsboro, Essex co. G. van Ingen, collector. 1901.

3018 Beekmantown beds on shore of Lake Champlain at Fairchild's point at mouth of Boquet river, town of Willsboro, Essex co. G. van Ingen, collector. 1901.

3019 Potsdam sandstone on lake shore at Flat Rock point, 2 miles east of Willsboro, Essex co. G. van Ingen, collector. 1901.

3020 Beekmantown beds. Bed of Salmon river at crossing of Salmon river road at South Plattsburg. G. van Ingen, collector. 1901.

3021 M y t i l u s e d u l i s bed in raised beach at the "Gravel pit" 1 mile west of Lapham Mills, Clinton co. G. van Ingen, collector. 1901.

3022 Potsdam sandstone in bank of Saranac river at lower end of "Mill D" at Kent Falls, 7½ miles west of Plattsburg. Horizon 258 feet above that of 3000. G. van Ingen, collector. 1901.

3023 Potsdam sandstone in bank of Saranac river at lower end of "Mill D" Kent Falls. Horizon immediately above that of 3022.

3024 Chazy limestone. Road from West Chazy to Chazy, 1½ miles east of West Chazy, Clinton co. G. van Ingen, collector. 1901.

3025 Potsdam-Beekmantown transition beds in bed of Big Chazy river at the Champlain waterworks and dam, 1½ miles west of Champlain, Clinton co. G. van Ingen, collector. 1901.

3026 Potsdam sandstone. On Champlain to Mooers road, 2¾ miles east of Mooers, Clinton co. G. van Ingen, collector. 1901.

3027 Potsdam-Beekmantown transition beds in village of Ticonderoga, near the junction of East Exchange and River streets. G. van Ingen, collector. 1901.

3028 Potsdam-Beekmantown transition beds near the junction of East Exchange and River streets in the village of Ticonderoga. 10 feet above 3027. G. van Ingen, collector. 1901.

3029 Potsdam-Beekmantown transition beds on left bank of Ticonderoga creek at north side of mill, below East Exchange street bridge, Ticonderoga. G. van Ingen, collector. 1901.

3030 Trenton shales in bed of Saranac river at South Catherine street bridge in village of Plattsburg. G. van Ingen, collector. 1901.

3031 Potsdam sandstone. Ausable chasm at the place called "Mecca", just below the "Devil's Oven". Ausable chasm, Clinton co. G. van Ingen, collector. 1901.

3032 Potsdam sandstone. Same layer as 3031 but exposed at the mouth of Mystic gorge in Ausable chasm, about 200 feet down stream from 3031. G. van Ingen, collector. 1901.

3033 Potsdam sandstone. Same layer as 3031, but exposed at west end of Hyde's cave bridge. 300 feet down stream from 3032. Ausable chasm. G. van Ingen, collector. 1901.

3034 Potsdam sandstone. Same layer as 3031, but exposed at upstream end of bridge over Smuggler's pass, 250 feet down stream from 3032. Ausable chasm. G. van Ingen, collector. 1901.

3035 Potsdam sandstone. Same layer as 3031, but exposed at level of path-railing at the "Postoffice", 250 feet down stream from 3034. Ausable chasm. G. van Ingen, collector. 1901.

3036 Potsdam sandstone. Same layer as 3031, but exposed in hillside at upper rapids below Cathedral Rocks at a point about 2100 feet down stream from 3035. Ausable chasm. G. van Ingen, collector. 1901.

3037 Potsdam sandstone. Same layer as 3031, but exposed at top of door on stairway leading up bank from Cathedral Rocks. Ausable chasm. G. van Ingen, collector. 1901.

3038 Potsdam sandstone. Layer just below 3033 at level of path-railing between "Mystic gorge" and "Smuggler's pass", Ausable chasm. G. van Ingen, collector. 1901.

3039 Potsdam sandstone. Hyolithes bed at level of "Table rock" at foot of Cathedral Rocks, Ausable chasm. G. van Ingen, collector. 1901.

3040 Potsdam sandstone. Same layer as 3039, but exposed in hillside at Upper Rapids below Cathedral Rocks, Ausable chasm. G. van Ingen, collector. 1901.

3041 Potsdam sandstone. Obollela layer, 15 feet above 3036 in hillside at Upper Rapids below Cathedral Rocks, Ausable chasm. G. van Ingen, collector. 1901.

3042 Potsdam sandstone. Obolella layer at top of Cathedral Rocks, 50 feet above 3036, Ausable chasm. G. van Ingen, collector. 1901.

3043 Chazy limestone. Drift on shore of Lake Champlain at Port Kent. G. van Ingen, collector. 1901.

3044 Beekmantown beds. In field west of D. & H. R. R. track and north of wagon road that crosses the railroad 1 mile north of Beekmantown station, Clinton co. (Whitfield's locality of Ophileta beds. Am. mus. nat. hist. 2) G. van Ingen, collector. 1901.

3045 Potsdam sandstone. Layer with Linguloid shells 15 feet above 3039 at foot of stairs leading up cliff at Cathedral Rocks in Ausable chasm. G. van Ingen, collector. 1901.

3046 Chemung beds. West hill, Lincoln gully, Naples. 1380 feet A. T. D. D. Luther, collector. 1901.

3047 Lockport (?) dolomite. Pittsford; on Allen creek ½ mile west of canal. D. D. Luther, collector. 1901.

3048 Guelph dolomite. Galt, Ont. William Herriot, donor. 1902.

3049 Chemung beds. Hamlin pasture 2 miles southeast of Naples on Knapp hill. D. D. Luther, collector. 1901.

3050 Chemung or Ithaca beds. West hill above Cumming's crossing, Naples. D. D. Luther, collector. 1901.

3051 Lockport (?) dolomite. Pittsford; on Allen creek between canal and Auburn R.R. D. D. Luther, collector. 1901.

3052 Salina beds. Black shale lying at or near the base of the Salina formation. Pittsford; canal bank near Cold Spring House. D. D. Luther, collector. 1901.

3053 Chazy limestone. Day point, Valcour. G. van Ingen, collector. 1901.

3054 Portage (Ithaca) shales. Spafford, Onondaga co. D. D. Luther, collector. 1895.

3055 Naples shales. Plum creek, village of Himrod, Yates co. 170 feet above Seneca lake. J. M. Clarke, collector. 1895.

3056 Naples shales. Belknap's gully 2 miles north of Branchport, Yates co. J. M. Clarke, collector. 1895.

Continuation of record of localities of fossils collected in area covered by Salamanca quadrangle. Charles Butts, collector. 1901. See section, 2875.

3057 2 miles slightly southwest of Salamanca; road about 2000′. Station 260, no. 7.

3058 Cut by roadside about 2 miles southwest of Salamanca, ¼ mile above and west of station 260. Station 261, no. 3.

3059 Near triangulation station on top of 2375′ summit, east of south of Salamanca. Station 264, no. 3.

3060 Short distance south of cross roads, up Beehive creek. Station 265, no. 7.

3061 Hillside east of junction of Bova and Red House creeks. Station 266, no. 7.

3062 Hillside east of junction of Bova and Red House creeks; 40 feet above station 266. Station 267, no. 7.

3063 Crest of nose east of junction of Bova and Red House creeks. Station 268, no. 7.

3064 Buffalo, Rochester and Pittsburg railroad cut near highway crossing at Carrollton. Station 271, no. 8.

3065 Old quarry just above highway, short distance south of Carrollton. Station 272, no. 7.

3066 Top of nose nearly 1 mile due east of Carrollton. Station 273, no. 7.

3067 Crest of nose east of Carrollton. Station 275, no. 3.

3068 15 feet of top of 2200′ summit east of Carrollton. Station 276, no. 3.

3069 Roadside head of hollow, little over 1 mile southeast of Sugartown, Humphrey township, near western boundary. Station 326, no. 7.

3070 West side of hill between Chipmunk and Tuna creeks. Station 278, no. 7; station 277, no. 7.

3071 Crest of ridge between Chipmunk and Tuna creeks, nearly due east of Irvine Mills. Station 280, no. 4.

3072 Near forking of Irish and Rice brooks, west of Tuna creek. Station 281, no. 7.

3073 Roadside a few rods west of road forking Irish brook and Rice brook roads. From boulder. Station 282, no. 4.

3074 Near top of hill at head of Irish brook. Station 285, no. 3.

3075 In road near east branch of Red House brook. Station 287, no. 4.

3076 Short distance south of Halls, Red House brook road. Station 288, no. 7.

3077 Just north of summit by road, 3 miles north of Salamanca, at head of Newton run. Station 312, no. 3.

3078 Road near McIntosh creek $1\frac{1}{2}$ miles from Red House brook. Station 289, no. 7.

3079 Crest of ridge between Tuna and Chipmunk creeks. Station 291, no. 4.

3080 North slope of ridge between Tuna and Chipmunk creeks. Station 292, no. 4.

3081 North slope of ridge between Tuna and Chipmunk creeks, 30 feet below station 292. Station 293, no. 7.

3082 1 mile east of Riverside junction, Carrollton township, 50 feet below station 294. Station 295, no. 7.

3083 1 mile east of Riverside junction, Carrollton township, 50 feet below station 295. Station 296, no. 7.

3084 Roadside just south of junction of roads at twine mills, Tuna Valley. Station 297, no. 7.

3085 Hill north side of Killbuck station. Stations 298–300, no. 7.

3086 Hill south of Salamanca. Station 302, no. 7; station $302^{1,2}$, no. 7; station $302^{3,4}$, no. 4.

3087 Cut on Buffalo, Rochester and Pittsburg railroad, 2 miles east of Salamanca. Station 303, no. 7.

3088 Cut on Buffalo, Rochester and Pittsburg railroad, 3–4 miles east of Salamanca. Station 304, no. 8.

3089 Spur west of Carrollton and west of river. Station 305, no. 7.

3090 Roadside on road northwestward up Great Valley creek, about $\frac{3}{4}$ mile north of Killbuck station. Station 306^1, no. 7.

3091 Road, Hungry hollow, 3 miles west of Great Valley. Station $307^{1,2}$, no. 7.

3092 Newton run $\frac{3}{4}$ mile north of Salamanca. Station 310, no. 7.

3093 Old quarry about 1 mile north of Salamanca up Newton run. Station 311, no. 7.

RECORD OF FOREIGN LOCALITIES

Specimens bearing lemon yellow tickets

105 Taunus quartzite (lowest Devonic). Katzenloch near Idar, Rhineprovince. E. Kayser, Marburg, donor. 1900.

106 Siegen grauwacke. Siegen, Germany. E. Kayser, Marburg, donor. 1900.

107 Upper Siluric. Island of Oesel, Livonia, Russia. Purchased of Dr F. Krantz (Mineralien-Contor) Bonn, Germany. 1901.

APPENDIX 3

CONTACT LINES OF UPPER SILURIC FORMATIONS ON THE BROCKPORT AND MEDINA QUADRANGLES

TRAVERSES BY J. M. CLARKE, R. RUEDEMANN AND D. D. LUTHER, 1901

Brockport quadrangle. *Clinton beds.* At Adams Basin on the Niagara Falls road the Clinton limestones are exposed at one or two points along the banks of Salmon creek. Not far back from the railroad culvert crossing this creek was formerly a small quarry in the cherty thin limestone slabs of the upper Clinton (station 18; 520±feet A. T.).

Station 15. In the bottom of Salmon creek at crossing of first east and west road south of Adams Basin, thin relatively pure Clinton limestones with Hyattella congesta (elevation 525 feet A. T.).

Still farther up stream and along the east branch about 1/3 mile are more silicious Clinton flags lying close to the top of the series.

Rochester shale. Station 17; 20 rods beyond this point on the same stream is an outcrop of Rochester shale with Spirifer radiatus, Dalmanites limulurus, etc. This is the base of the Rochester shale and its elevation is 570 feet A. T. The change from the Clinton to the Niagara shale is not marked by topographic features and there appears to be no surface evidence of the passage of the one formation into the other. South of Spencerport the contact line crosses the creek running through that village at just about or near Ogden Center, and follows approximately the 600 foot contour line. To the west the topography indicates no abrupt or noteworthy change in the position of this line but outcrops are of very rare occurrence. In the traverse from Adams Basin southward no other outcrops of the Niagara shale were observed.

Lockport dolomites. Station 14. Elevation 625 feet A. T. This is a spot on the farm of E. Arnold, township of Ogden just east of the highway leading due south from Adams Basin where a thin, quite pure somewhat crinoidal dolomite has been taken out in small quantity for local construction purposes.

As the differences in surface elevation between this limestone and the outcrop of Niagara shale previously noted is but about 45–50 feet and the north-south interval between the two stations about 1 mile, it is evident that this is one of the layers, if not the basal bed, of the series of Lockport dolomites. The exposed thickness here is from 1–2 feet.

Station 13. At the four corners due south of station 14 in a field to east of road is an outcrop of gray, somewhat scraggy dolomite, 3 feet. Elevation on topographic sheet approximately the same as that of station 14, the stratum probably lying close on that exposed at former station. These scraggy dolomites carrying some silicious nodules and silicified fossils (Favosites, Stromatopora, etc.), their roughened surfaces due to unequal weathering, are exposed at various points to the east and west of this road north and south of the hamlet of Ogden and from the elevation stated where they immediately overlie the rock at station 13, through an interval of about 40 feet. These outcrops are also to be observed freely throughout the region east and west, specially along the first east and west road north of the Ogden road, and from there westward.

Stations 12, 11, 10, 6, 5 and 4. These very characteristic scraggy dolomites vary little in texture and color. For the most part the outcrops show the usual rough surface with considerable chert often replacing the corals but so far as observed other fossils than corals or Stromatopora are seldom present. Here and there, as at station 11 on the north and south road the first east of the Ogden-Churchville highway, the rocks have a smoother, more homogeneous character and carry less chert. This layer however appears to be one intercalated between other layers of the more silicious material. Similar exposures of these dolomites indicated for the most part by boulders loose above concealed outcrops, are to be seen over the territory to the west, approximately along the boundary line between the towns of Bergen and Sweden.

Salina beds. The lower limit of the Salina in this section is indicated by an outcrop on the road from Churchville to North

Chili and lying about half the distance between these two points, or 2 miles from Churchville. Here are exposed (station 9) the green shales of the basal Salina. The nearest outcrop of the Lockport dolomite is about 1 mile north of this and ¾ mile to the east, being at station 6 on the first north-south road east of the road from North Chili to Spencerport. No closer approach of the two formations could be observed, but the topography of the region seems to clearly indicate the contact of the limestone with the soft Salina shales above along an approximate east and west line through this region. On account of the drift mantle, the limestone outcrops do not make a specially noteworthy feature of the topography. The extent of the Salina in the vicinity of Churchville and south of North Chili is indicated by outcrops recorded (station 8) just south of Churchville village in drain excavations on the Riga road. Also along the banks of Black creek at station 7, near the confluence with a branch from the west, 1 mile south of Churchville, where are 15 feet of mottled red green and gray shales. At station 1, 3 miles southeast of Churchville, 15 feet of greenish and gray shales are exposed on both sides of the creek and extend in interrupted exposures as far as the road to Buckbee Corners, crossing the creek. Thus it is evident that the region north of Black creek to the last outcrop of the Lockport dolomite, a distance of 3 miles, is covered by the soft shales of the basal portion of the Salina.

Albion quadrangle. *Medina sandstone.* Holley. The extensive quarries in the Medina sandstone about Holley and the sections afforded along the banks of Sandy creek coming in from the south, give an instructive exhibit of the character and variations in this formation. Along the banks of the creek to the north of the town (station 22) are banks of red and green shale 15 feet thick and the lower sandstones are exposed in rather thin red and brownish beds much mottled and interlaminated with white, but with a single heavy homogeneous red layer at the bottom. At a quarry near the towpath at the crossing of the first north-south road east of the village, above the red

sandstone, those of paler color passing into white are shown in the upper exposures along the creek for 1½ miles south of the village. From Holley to Clarendon the Medina extends for apparently about 2 miles but aside from the creek section is covered.

Clinton beds and Rochester shales. At Clarendon (station 23) and along the escarpment west of the east branch of Sandy creek are noteworthy exposures of Clinton limestone, continuing from just north of the village to 1½ miles to the south.

Other exposures of Clinton limestone were not observed and the topography soon becomes depressed so that the existing Rochester shales are, so far as our observations extended in this section, concealed.

Lockport dolomites. At about 1½ miles south of the last observed exposure of the Clinton limestone, just north of the settlement known as Honest Hill, and to the west of the highway leading to Byron, is a small quarry on the Arnold farm from which thin slabs of gray, comparatively pure or slightly dolomitic limestone have been taken and this rock seems to pertain to the base of the Lockport dolomitic series. The country here enters the eastern arm of the Oak Orchard swamp and other outcrops are here concealed, the only additional evidence of the presence of the dolomite series being found at the south edge of this swamp land where occasional accumulations of the scraggy upper dolomites are to be observed. At one point just north of Pumpkin hill on a northerly branch of Black creek these layers were at one time brought together and burned for lime, the kiln and piles of accumulated material still being in evidence. After passing the probable southern limit of the dolomite area approximately along the course of Black creek, the country becomes so low and marshy, specially to the east in the direction of Bergen, that no outcrops are afforded and from Byron to Elba a distance of 6½ miles, and from Elba north to Langton Corners, 1 mile, and from there north 1½ miles to the east and over various points along that road southward to East Oakfield and thence to Oakfield village, no outcrop could

be ascertained at any place. For this area we are therefore compelled to construct from the data brought together from the adjoining territory the probable contact lines, clearly indicated in some places by actual exposures and suggested with strong probability in others.

Medina quadrangle. The country forming the south boundary of the Oak Orchard and Tonawanda creek swamps is likewise barren of any trace of outcrop. The region was carefully traversed from Oakfield, where the gypsum beds of the Salina are extensively wrought, 3 miles to Bumpus triangulation station, thence west to Wheatville, Alabama and West Alabama, south to South Alabama and Smithville station. It is appropriate to note from the conditions here displayed by the topography that the great swamp area which extends entirely across this Medina quadrangle rests on the excavated Salina shales or the dolomite series beneath, from which the shales have been removed.

North from the Tonawanda reservation along the drainage canal running into Oak Orchard creek at a point from 1¾ to 1 mile south of Shelby where this channel was excavated through the rock, are exposed a succession of the Lockport dolomites.

Station 27. Where the first east and west road south of Shelby crosses the creek, the lower rock is a bluish gray dolomite weathering brown, in thin rough layers from 3-12 inches thick. Fossils occur in this rock, most abundant of which are Zaphrentis and other corals, with Stromatopora. Above this is a band of coarse grained dark dolomite 4 feet thick, some of the layers of which are quite soft and shaly. Here also are found small corals. At the top of this band is a well defined change in the character of the deposition, the rock becoming a more compact and more heavily bedded brown scraggy dolomite. 6 to 8 feet of this rock are exposed along the creek for a total distance of about a half mile, and a very large amount taken from the channel six or eight years ago is piled up in heaps on the banks. Just above the bridges on the north and south road the rock dips below the bottom of the excavation but is brought

up again 40 rods south by a low ridge and forms the sides and bottom of the channel for nearly ¼ mile, showing about 5 feet of the base of the uppermost layers and at the apex of the fold a foot or two of the shaly layer beneath it. This is the most southern exposure on Oak Orchard creek. Fossils obtained show it to be the horizon of the Guelph dolomite.

Rochester shale. Station 28. The falls at Shelby village. The exposure here shows the lower silicious layers of the Lockport limestone of which about 30 feet are seen in the falls. These beds are very close on the base of the limestone series for at a short distance farther down the stream is an outcrop of the upper Rochester shale bearing a 1 foot silicious bed in the middle of the bluff, and just below on the face of the escarpment which is indicated by the 600 foot contour line of the topographic map is a clean cut exposure of this shale.

Clinton beds. Station 29. No further outcrop is seen along the course of the creek till the southern outskirts of Medina village are reached where (station 30) is an outcrop on the creek bank ¼ mile north of the dam, exposing crystalline crinoidal limestone with well defined Clinton fossils.

Medina sandstone. A few rods farther down (station 31) the creek exposes a white greenish coarse sandstone of the upper Medina, and from there north Medina sandstone exposures are of frequent occurrence throughout the region. From these observations we have the means of identifying with approximate accuracy the contact lines of the Medina-Clinton, Clinton-Rochester and Rochester-Lockport beds.

Relation of the Oak Orchard swamp to these rock formations. A map of sufficient size such as the topographic sheets of Albion and Medina indicating the extent and distribution of the swamp areas in this region, shows that one can not ascribe to any lithologic differences in these formations a sufficient cause for the present area of these swamps. The marsh along the course of Black creek between Byron and Bergen doubtless lies on the Salina shales or is underlain by a pavement of Lockport dolomite where those shales have been removed. But we observe

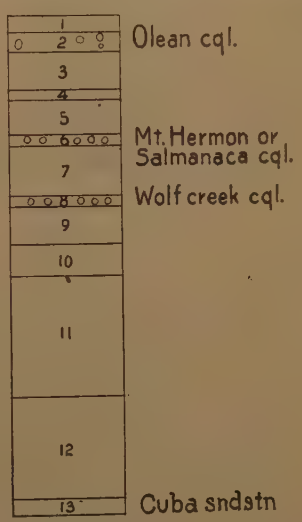
over the area which must be ascribed to the exposures of Lockport dolomites where at least the dolomites must be in main the underlying rock, thé considerable, often thin, broken and interrupted extensions of the swamp areas. The rock ridge showing just north of Churchville and North Chili thence westward beyond Shelby, a ridge composed of the Lockport dolomites, may hold the key to the artificial drainage of the major swamp areas. The great body of the swamp north and south covers not only the width of the Lockport dolomite but also that of the Rochester shale and extends farther to the north than it is proper to draw the dividing line between the Clinton and Medina. From this consideration then it becomes evident that the heterogeneous character and the differential erosion of the underlying rocks are not a sufficient cause for the present distribution of the swamp areas, and while this is doubtless an efficient contributory cause for the actual existence of these extensive depressions, their original boundary has been exaggerated by artificial obstruction to drainage.

PRELIMINARY STATEMENT OF THE PALEONTOLOGIC RESULTS OF THE AREAL SURVEY OF THE OLEAN QUADRANGLE

BY JOHN M. CLARKE

In the course of this work undertaken with the cooperation of the U. S. geological survey during the season of 1900, operations were carried on mainly by Prof. L. C. Glenn with the assistance of Charles Butts. Mr Butts was specially concerned in the collection of paleontologic data from all available stratigraphic horizons and the careful study and determination of material accumulated by him has led to a pretty clear understanding of the succession of the faunas in the district. It has been well understood that the lower lands of the region were underlain by rocks which could be referred without question to the upper layers of the Chemung formation but the strata capping the hills of the southern portion of the area have been variously referred to the Devonic and in part to the lowest beds of the Carbonic. The vagueness of this reference and the want of any recognized line of division between accepted Devonic and supposed Carbonic has been due partly to lack of requisite study and partly to the gradual and undisturbed succession of sedimentation. Between what has heretofore been supposed to be Carbonic (without taking into account any more exact denomination of the horizon) and the recognized Chemung is a series of beds which has been usually termed Catskill and in part so represented on the geologic maps of the state. One of the direct purposes of this work was to determine the value of these beds over an interval where a passage from one of the great paleozoic systems into another was clearly to be looked for. That there is no Catskill sedimentation here in the true meaning of the word, i. e. Catskill in the sense of implying estuarine sedimentation with distinctive organisms of fresh or brackish water habit such as occur in the typical section of eastern New York, is made quite probable. In a general way the section of sediments from north to south across this sheet

is represented by the accompanying diagram where the strata are numbered from top to bottom by the figures 1-13 inclusive. The region is a country of sandstones and flags with interbedded conglomerates and the nature of these beds is sufficiently explained in the matter on the diagram. It will be noted that in this series there are two well defined and heavy sandstones and two equally conspicuous and heavy conglomerates. The lowest of these sandstone beds is stratum no. 13, the Cuba sandstone. 600 feet above it lies stratum no. 8, the Wolf creek conglomerate. Above the latter 200 feet, is the Mount Hermon or Salamanca conglomerate, no. 6, and from there the section rises about 200 feet to the Olean conglomerate, no. 2; the highest sediment in the series being the calcareous shales lying on the top of the last named conglomerate which has been termed the Olean shale. Intervening between the Wolf creek conglomerate and the Mount Hermon sandstone the beds are red and green shales interbedded with flaggy sands, to which it has been proposed to apply the term Cattaraugus beds. The validity and usefulness of the distinctive term for these strata which represent those at times referred to the Catskill formation because of their red color and doubtless a western continuation of Catskill sedimentation is very clearly indicated by the paleontologic evidence which they have furnished. For the shales above the Mount Hermon sandstone and thence to the base of the Olean conglomerate it has been suggested that still another distinctive term would be required, but it is not clear that stratigraphic evidence would favor such determination. The propriety of the subdivision could be established by the variation in the fossil contents, should this appear to be of



sufficient weight. In the study of the vertical distribution of the fauna of this succession, the following points come out with clearness.

Of these 13 columns no. 8 represents the Wolf creek conglomerate and no. 6 the Mount Hermon conglomerate. It is the former which proves to be the important line of change in the succession of the faunas. It is to be understood that there is no evidence in this undisturbed and unfolded region of any abrupt change by sudden extinction of species or by unexpected invasion from east or west, but the succession has gone on without interruption and it is only at that horizon where a decided change becomes noticeable without the extinction of all preexisting forms.

1 Up to the Wolf creek conglomerate the common Chemung species seem to prevail. For example, Spirifer disjunctus, Athyris angelica, A. cora, Chonetes scitula, Orthis tioga, Orthothetes chemungensis, Productellas of various species, Mytilarea, Nucula bellistriatra, Aviculopectens, Crenipectens, Edmondia, some of the Leptodesmas such as L. potens and var. juvenis, L. mortoni, L. sociale, Pterinopecten, some of the gastropods like Bellerophon maera, Euomphalus hecale, Macrochilina and the Dictyosponges.

2 Some characteristic Chemung species pass this limit. Thus, for example, Spirifer disjunctus, which is usually regarded as an index fossil of upper Devonic time, extends beyond the Wolf creek conglomerate up to and within the shales beneath the Olean conglomerate, becoming however of very rare occurrence in horizons above no. 8. Camarotoechia contracta is recorded from all horizons from the base up to and into the Mount Hermon or Salamanca conglomerate. Such species as these however, of which we have cited the most striking instances, must be looked on in the face of the rest of the evidence as having their value as diagnostic of Devonic time modified by the introduction before their extinction of a

striking number of new forms altogether foreign to deposits of earlier age. They are thus in this sense and for the section we have under consideration, superstitial species, that is, purely survivors which have held their ground in the face of organic modifications and change of physical conditions going on about them.

3 The Wolf creek conglomerate marks the dawn of a number of species. Thus a species of the brachiopods, Oehlertella, not to be distinguished from O. pleurites which abounds in the Bedford shales of Ohio, appears here and also in the overlying stratum no. 7. Of the Leptodesmas, L. orodes here appears; also Modiola praecedens and a considerable number of the Ptychopterias; some are identifiable with previously known species and others appear to be of variant form. With a single doubtful exception all these Ptychopterias appear at this horizon or above it. Palaeanatina typa also makes its appearance here. The effect however of this conglomerate in the strata is less marked in this respect as the point of departure of novel forms of the series than as a dividing line in the succession of faunas. We may indicate the contrast in the aspect of the faunas above and below this line by the following columns:

Above base of Wolf creek conglomerate	Below base of Wolf creek conglomerate
Agelacrinus buttsi	Athyris angelica
A. polita	A. cora
Camarotoechia allegania	Chonetes scitula
Oehlertella pleurites	Schizophoria 2 sp.
	Productella 5 sp.
	Edmondia 3 sp.
	Leptodesma potens
	" " *var.* juvenis
	" mortoni
	" sociale
	" matheri
	" longispinum
	" protextum
	" spinigerum

Above base of Wolf creek conglomerate	Below base of Wolf creek conglomerate
Leptodesma orodes	
" curvatum	
" maclurii	
" mytiliforme	
	Mytilarca chemungensis
	Nucula bellistriata
Pararca 3 sp.	
Ptychopteria 8 sp.	
Palaeanatina 2 sp.	
Bothriolepis	
Ctenodus	Pterinopecten 2 sp.
	Dictyospongia
Holoptychius	Prismodictya 2 sp.
Gyracanthus	Thysanodictya 2 sp.
Fishes	

It becomes quite clear that a fundamental change has entered on the nature of the fauna with the deposition of the Wolf creek conglomerate and in the species herewith commencing their existence we find a certain well defined aspect of Carbonic life, the presence of which is supplemented by the abrupt disappearance of the leading features of the Chemung fauna. We have made special reference to Oehlertella pleurites and have already in another place discussed the characters of the Agelacrinites buttsi from the stratum 5 which shows a close affinity to cystids of the early Carbonic. It is to be further noted that the post or supra-Carbonic aspect is indicated by the Ptychopterias and Pararcas rather than a true Devonic though the presence of heraldic forms of these genera in Devonic strata is not to be questioned. Yet here by their profusion they indicate a faunal aspect which is peculiar to this horizon. Attention may be directed to the presence of fish remains which have been found in the red beds of stratum no. 7, and of them some, like Holoptychius americanus, may be regarded as suggesting the horizon of the Catskill of eastern New York, while others, Gyracanthus, Ctenodotus and Bothriolepis point with more definiteness to a higher horizon.

THE POTSDAM SANDSTONE OF THE LAKE CHAMPLAIN BASIN

NOTES ON FIELD WORK 1901

WITH MAP

BY GILBERT VAN INGEN

The Potsdam sandstone of northern New York is, in the bibliographic sense, one of the best known members of the geologic column. For many years it was considered the lowest member of the series of sedimentary rocks, and was, as such, supposed to contain the oldest known representatives of organic life. In this relation the description of the formation was given considerable prominence in textbooks and its name became a familiar one to students of natural history. In view of these facts it is a matter of surprise that there is at hand so little definite information regarding the physical and biologic characteristics of this formation, which is in reality the least known element of the sedimentary series of New York. Since the original description of the formation by Emmons in 1837-43 little has been added to our knowledge of it as developed within the boundaries of this state. Logan[1] described with considerable detail the group as developed in its northward extension into Canada and added several items of interest to those noted by Emmons. Walcott[2] gives a few notes on the relations of the Potsdam to the overlying formations in the vicinity of Saratoga and Washington counties. Again in 1891 Walcott briefly describes several sections through the formation along the northern and eastern flanks of the Adirondack mountains, in which are given the thickness of the deposits, general statements on the character of the materials, and in which certain fossiliferous zones are recognized as occurring at horizons in the upper part of the series. Ells, 1894, in a paper on the Potsdam and Beekmantown formations of Quebec and eastern Ontario, describes the transition from the sandstone of the

[1] Geology of Canada. 1863. p. 87-96.

[2] U. S. geol. survey. Bul. 30. 1886. p. 21.

Potsdam to the dolomite of the Beekmantown in southern Canada, and concludes from examination of the stratigraphic and physical evidence that the Potsdam should be considered the base of the Siluric system, instead of the uppermost member of the Cambric. More recently the reports by Cushing on the geology of Clinton county have contained some interesting descriptions of the physical characters of the Potsdam sandstone at several localities on the northeastern slope of the Adirondacks. The reports on the geology of the eastern flanks of the mountains along the shore of Lake Champlain afford little more than descriptions of the areal distribution of the sandstone.

Some descriptions of fossils found in the formation have been published, in nearly all cases however without reference to the particular horizons within the formation from which they were obtained. Walcott's sections are the only descriptions extant in which the fossils are referred to definite horizons in the sections.

The above statements will indicate that up to the present time no systematic attempt has been made to study the formation in its entirety throughout its distribution round the western, northern and eastern slopes of the Adirondacks and as a result the following questions remain entirely or in great part unanswered.

1 What are the relations of the Potsdam to the subjacent formations, whether the latter be of pre-Cambric or lower Cambric age?

2 What are the relations of the Potsdam to the superjacent beds of the lower Champlainic (Siluric) series?

3 Where shall the upper limit of the Potsdam be drawn?

4 What are the physical characters that may serve as a means of distinguishing the lower from the middle and upper portions of the Potsdam sandstone?

5 What are the fossil contents of the Potsdam and may they be grouped to form distinct biologic zones? To what extent are they reliable as a means of subdividing the formation and recognizing the lower, middle and upper portions?

6 The Potsdam sandstone being a litoral deposit, what is its deeper water facies?

At the request of the state paleontologist and with a view to securing information toward a solution of some of the above mentioned problems, field work was commenced in the vicinity of Plattsburg, Clinton co. and extended southward through the towns of Plattsburg, Schuyler Falls, Peru and Ausable, into Chesterfield, Essex co. Special trips were also made to Willsboro and Crown Point, Essex co. in the vicinity of which villages the Potsdam has been described as exposed in close proximity to beds of the overlying Beekmantown series. Northward from Plattsburg the work has been continued into the towns of Beekmantown, Chazy, and Champlain.

The following sections, brief synopses of which are given, have been examined with care.

Valley of the Saranac river from above Cadyville to its mouth at Plattsburg, a distance of 10 miles.

Valley of Salmon river from Peaseleeville to its mouth, 11 miles.

Valley of Little Ausable river from above Peru to its mouth, 7 miles.

Valley of Dry Mill brook near Valcour, 3 miles.

Valley of Ausable river from above Keeseville, through Ausable chasm, about 4 miles.

Valley of Boquet river at Willsboro from village to lake and along lake shore, total 5 miles.

Railroad cut along D. & H. track at Burdick's crossing north of Crown Point, about 1½ miles.

Synopsis of sections

Saranac river section from near Cadyville to its mouth at Plattsburg, length about 10 miles

General strike of beds north with an easterly dip of from 5°–10°. Direction of section easterly. Formations Potsdam to Trenton.

This section is described somewhat in detail as it serves as typical of the middle and upper portions of the Potsdam formation of this vicinity.

The lowest beds, 125–B1, of the sandstone are at the Ellis dam on the Saranac river about 1 mile above Cadyville, from which point the sandstone is exposed at intervals down the river for a distance of 2 miles to a point below the mill at Kent Falls, where the highest layer, 125–A13, of the Potsdam in this section is seen dipping into the river. Below this latter point the next outcrop of rock is of lower Beekmantown horizon, 127–B1 to 3, at Treadwell's mill, 5 miles down the river. The intervening space of 5 miles is occupied by drift deposits and it is impossible to determine how much of the area is underlain by Potsdam sandstone and how much by the Beekmantown beds. Still farther down the river, 2¼ miles, the Chazy limestone, 127–A4, outcrops in the river bed with the same general easterly dip. A short distance beyond the Chazy outcrops the Trenton limestone appears in the stream and continues to the lake shore. Throughout the entire section the strike and dip has little variation; the strike changing from N 15° W to N 15° E, and the dip from 5° to 10° degrees easterly. There is no evidence of faulting to increase the apparent thickness of the deposits by duplication of beds. Computing from the length of section, strike and dip, and difference in altitude between the exposure of lowest layer and that of highest layer, we obtain from the Potsdam an estimated thickness of 1150 feet, of which amount the upper 350 feet is fossiliferous.

The lower portions of the formation as seen in this section are of light color; generally gray, with variations to yellowish and bluish gray and occasionally pink tints. The material is quartz sand, well cemented with silicious cement, the grains being both angular and somewhat rounded and varying in size from ½–2mm, with grains of 4 mm diameter on the surfaces of some layers. Many layers contain a considerable admixture of small grains of partly kaolinized feldspar. The layers vary in thickness from 6–24 inches and are as a rule quite compact. Ripple-marks are common on the surfaces of beds and cross-bedding is seen in nearly all layers. A few layers have thin pebbles of shaly material on their upper surfaces, but no

shale pebbles were seen embedded in the midst of layers in this portion of the section. No traces of fossils were found.

This description applies to the rock as exposed at the Ellis dam and just below "Mill C" of the International paper co., 1½ miles down the river, and also to the lower part of the section at Kent Falls, 125–A1.

The upper and fossiliferous portion of the sandstone in this section as seen at Kent Falls, 125–A2 to 13, differs in several important respects from the lower barren portion. The upper part has many layers of thinly bedded, greenish, argillaceous sandstone with shaly partings, on which are fucoids and worm trails. Other layers contain pebbles of shale and dolomite and in these layers are usually found the fossils, which consist of trilobites, brachiopods and gastropods. These upper layers are also wanting in feldspar. The sand grains of which they are made up are markedly rounder, and as a rule the cementation is not so thorough as it is in the lower beds. Heavy beds of compact, even grained, sandstone are less frequent than below.

The uppermost layer of this section is a heavy bed, 10 feet thick, of white, granular, quartz sandstone, with ripple-marked surface, and cross-bedded section. Its appearance is totally different from the heavy beds of the lower portion, its grains being slightly larger, more rounded, and less closely cemented, so that the rock crumbles readily under the blow of a hammer.

Synopsis of the Kent Falls section to show order of fossiliferous horizons, from below upward

125-A1	Barren sandstone	30 feet
125-A2	Irregularly bedded sandstone, shale partings; Lingulella and Obolella	5 feet
125-A3	Barren sandstone	25 feet
125-A4	Bluish sandstone thinly laminated; Lingulella abundant	5 feet
125-A5	Heavy sandstone; Scolithus linearis abundant	3 feet

125-A6	Sandstone in irregular layers; some heavy and compact, others thin, irregular, and shaly; all containing Lingulella in abundance and Obolella. Shale pebbles frequent on some surfaces, also fucoids	20 feet
125-A7	Sandstone in thin layers that split readily into thinner laminae. Lingulella, Obolella, Ptychoparia minuta?, Conocephalites verrucosus, in abundance	4 feet
125-A8	Sandstone thinly bedded and shaly in lower portion, heavy in upper portion; Linguloid fragments in abundance in lower portion	15 feet
125-A9a	Vertical interval unknown	about 70 feet
125-A9b	Thinly bedded sandstone with fucoids and ripple-marks	12 feet
125-A10	Irregularly bedded sandstone with pebbles and cavities; laminae separated by shaly partings; fossils most abundant near middle bed; Conocephalites verrucosus(?), Ptychoparia minuta (?), Lingulella, Obolella, worm borings, fucoids	4 feet
125-A11	Light colored thinly bedded, coarse grained sandstone, full of cavities due to solution of embedded pebbles; fossils, Trilobites (three species), Ophileta, Platyceras, Obolella, Lingulella, Scolithus canadensis. This fauna has a Siluric expression in the presence of the two gastropods, Ophileta and Platyceras	8 feet
125-A2	Vertical interval unknown	40 feet
125-A13	Granular, white quartz sandstone forming highest bed of this section; no fossils; ripple-marked and cross-bedded.	

The Beekmantown dolomite, 127-B1-3, appears first in bed of Saranac river at Treadwell's mill, 5 miles below Kent Falls,

and is exposed at intervals for 1 mile down stream to the Lozier dam, 127-B5. The rock at Treadwell's mill is a gray dolomite with an included 4 foot bed of fine grained black arenaceous shale, but at Fredenburg Falls, 127-B4, and at the Lozier dam, 127, 127-B5, it is a heavy, dark blue-brown dolomite, slightly arenaceous, with numerous geodes of yellow and pink calcite. No traces of fossils were found in any part of it. The shale at Treadwell's mill was carefully searched for Graptolites without finding any.

Salmon river section

The elevated land to the west of Peru and Lapham Mills, and to the southeast of Peaseleeville is due to the resistant character of the heavy beds of the lower portion of the Potsdam sandstone which covers the eastern slope of the gneissoid hill known as Terry mountain. The sandstone has a very thin covering of soil and drift and is exposed along the roads that traverse this region, which is locally known as "The Patent". These outcrops of the lower Potsdam, 129-Ao1, consist of ledges of coarse grained quartz sandstone with a considerable admixture of fresh, nonkaolinized feldspar. In color the rock varies from white to gray, yellow, and red. Ripple-marks and cross-bedding are common. No traces of fossils were found. Owing to the irregularity of the ground it was impossible to measure a section across this region. The general strike is northwest, with a dip of 5° or less to the northeast.

This portion of the sandstone belongs apparently at a much lower horizon in the formation than does that at Ellis dam on Saranac river.

Higher layers of the Potsdam are exposed at the mill dam and at the site of the old forge on the Salmon river at Norrisville, 1½ miles northeast of the exposures of 129-Ao1 on "The Patent".

At Norrisville, white sandstone, 129-Ao, 30 feet thick, is seen in the small gorge of Salmon river. The rock is heavily bedded in layers 2-3 feet thick, with much ripple-marking and cross-bedding, but with neither pebbles nor fossils, and has a diminishing amount of feldspar.

Again at Schuyler Falls, 2 miles down stream to the eastward, the sandstone is exposed in the bed of the river. The rock at this point, 129-A1, is about 50 feet thick; a heavily bedded white and gray quartz sandstone, with some intercalated layers of thinly bedded sandstone. These latter are ripple-marked and cross-bedded, contain some pebbles of green shale, and Lingulella and Obolella, and recall the lowest Lingulella-bearing bed, 125-A2, of the Kent Falls section.

No higher beds of the Potsdam are seen above those at Schuyler Falls; the next exposure being of the Beekmantown, 126-A1, with Ophileta and Lingula fragments, in the river bed at the crossing of the Salmon river road at South Plattsburg, 3 miles to the east.

Little Ausable river section from Peru to mouth of river

At the road-crossing in the village of Peru the Beekmantown dolomite appears in the bed of the river below both the upper and lower dams. From this point the river flows approximately along the strike of the beds to the northeast for 1½ miles to Lapham Mills, where its course changes to southeast and it flows over ledges of Potsdam sandstone.

The sandstone at Lapham Mills, 126-C3, has a thickness of about 50 feet, the exposure extending for ⅓ mile down the river from the railroad bridge, and is in some respects different from that seen at any of the other localities. The rock is generally a coarse sandstone of gray color with many layers of brown and red. These red layers are of great hardness and glassy fracture, and full of large grains of pellucid quartz that often attain a diameter of ½ inch. Ripple-marks and cross-bedding are common. No traces whatever of fossils.

One half mile farther down the river in an easterly direction is another exposure of Potsdam, 126-C2, forming ledges in the river bed. A total thickness of 10 feet is shown. The bedding is very irregular, the layers varying from 1–4 inches in thickness, often with shaly partings. The color ranges from white to gray, greenish, and brown; and the texture from fine to coarse. Some layers contain pebbles of schist and slate that attain sizes of 1–3

inches. These pebbles are in all cases flat like those of a shingle beach on a recent shore. Streaks of coarse grained quartz extend horizontally through some of the finer grained beds. The surfaces of the layers are usually covered by ripple-marks and sections show cross-bedding. No traces of fossils.

To the south, east, northeast, and north of this exposure are outcrops of the gray and blue Beekmantown dolomite. No determinable fossils have been found in any of these dolomites and it is now impossible to place them in any particular division of the series. It is also at present impracticable to determine their relations to the neighboring Potsdam. The strikes and dips of the separate exposures correspond sufficiently to allow the assumption that the two formations are here in their normal order of superposition. Other facts, however, seem to point to a different relation. The outcrops are far apart, ½ mile at least; and only 3 miles to the southward the two formations are faulted against each other. The lithic characters of the sandstone seem also to indicate that instead of belonging in the upper part of the formation it should be placed below any of the known fossiliferous horizons.

Dry Mill brook section in the town of Peru, Clinton co.

Dry Mill brook is a small stream that flows into the Ausable river about 1¾ miles north of the mouth of Ausable chasm. Just west of the crossing of Telegraph street the steel gray Beekmantown dolomite, 150-E6, forms ledges in the field. No fossils occur here.

Farther down the stream at the crossing of Lyon street, 1½ miles to the east, the dolomite, 150-E5, is again seen in the bed of the stream and continues from this point for 350 feet from the road bridge. At this point the dolomite is faulted against the Potsdam by a normal fault with downthrow to the west. To the east the Potsdam extends for a distance of 600 feet, with a thickness of 20 feet. The Potsdam here is a coarse sandstone of dark color with some layers that contain black pebbles, and a few thin layers of gray arenaceous shale. No fossils were found in it. Its horizon is unknown.

Port Kent

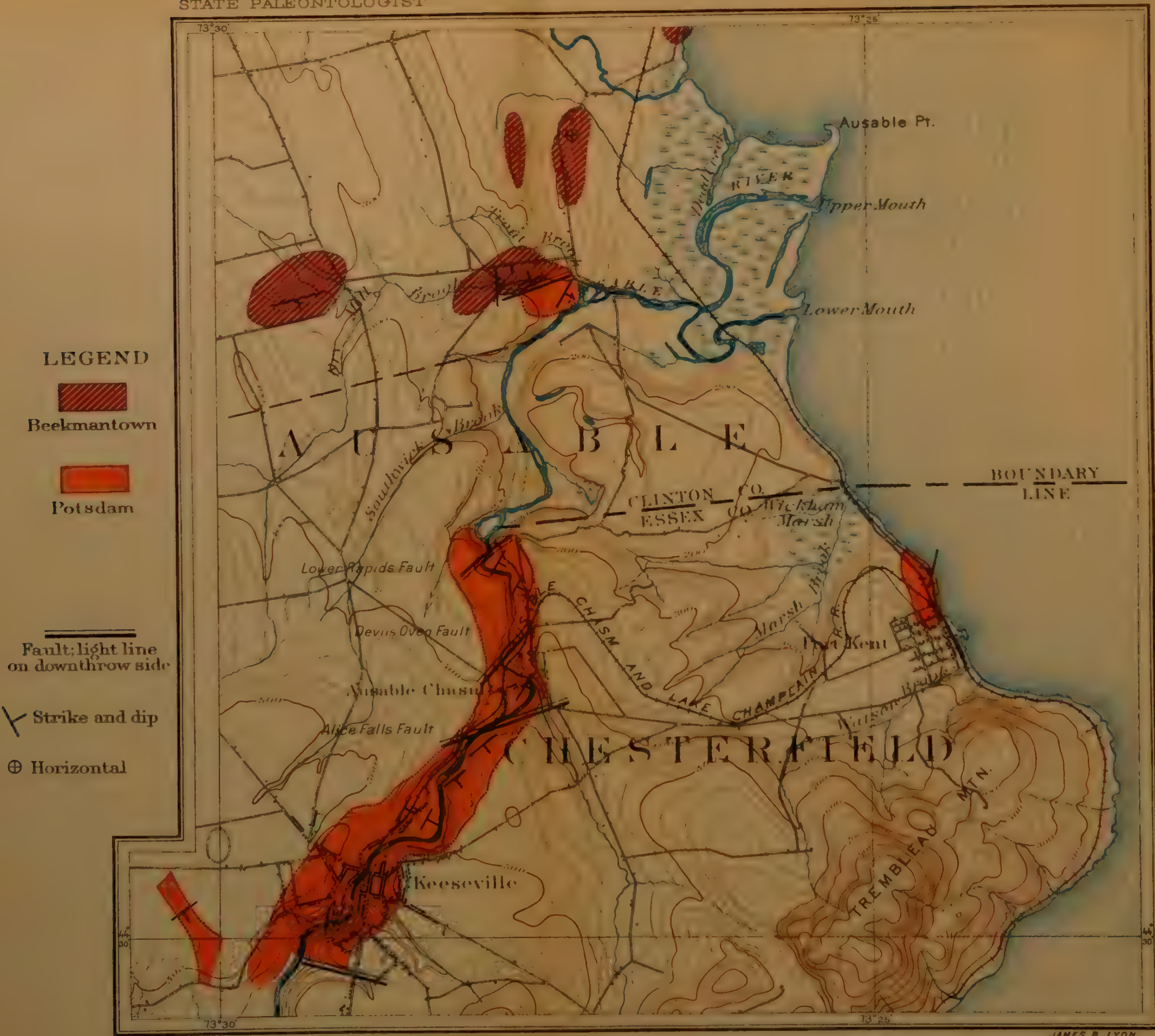
On the shore of Lake Champlain at Port Kent is a small exposure of the Potsdam sandstone, 124-A1. It is almost 1 mile north of the anorthosite of Trembleau mountain which juts out for some distance into the lake south of Port Kent station. The rock here is 20 feet thick and consists of heavy and thinly bedded layers of white and gray sandstone, some of which contain thin seams of black pebbles. Ripple-marks are common. No fossils. The rock is much broken by joints and the layers are bent; indications of proximity to a line of disturbance. These beds do not belong to the basal portion of the formation, and must be separated from the anorthosite by a fault.

Ausable river section from Keeseville through Ausable chasm

Near the road 1 mile west of Keeseville, just beyond the race-track, the base of the Potsdam sandstone, 150-E2, is seen lying in a depression between two ridges of anorthosite. The actual basal contact of the sandstone can not be seen. This locality was described in considerable detail by Cushing[1] in his report on Clinton county. The rock is here a coarse conglomerate of red sandstone containing gneissic fragments at the base, overlain by red sandstone of finer grain. The rock throughout the entire exposure contains a large amount of feldspar. Across the strike to the southeast the nearest exposure of the sandstone is on the bank of the Ausable river, about ½ mile above Keeseville, where it, 150-B1, outcrops in the vicinity of a boss of anorthosite on the right bank. This outcrop was mentioned by Walcott (1891, p. 343), and was evidently considered by him the basal portion of the sandstone. In reality it is an exposure along a fault which separates it from the anorthosite, and the rock here belongs to a horizon quite well up in the formation though just how far it is impossible to say.

From this point the sandstone is exposed at intervals for 1¾ miles to the dam of the pulp mill at Alice Falls, a short distance above the head of the Ausable chasm. Throughout this distance the beds exposed, 150-B1 to 7, are of the same character as those of the lower portion, 125-B1 to 2, and A1, of the

[1] N. Y. state geol. 15th an. rep't 1895. p. 548.



PORTION OF S. E. CLINTON AND N. E. ESSEX COUNTIES
SHOWING EXPOSURES OF POTSDAM AND BEEKMANTOWN STRATA
G. VAN INGEN. 1901

Scale $\frac{1}{62500}$

Contour Interval 20 feet

Datum is mean Sea level

Saranac river section. The total thickness is not determinable as the outcrops are not continuous and dip faults of considerable displacement are known to traverse the region. The minimum thickness is 60 feet which is the hight of the rocky bank on the south side of the Alice Falls fault.

Below the Alice Falls fault the exposures of the sandstone are practically continuous through the chasm.

The Keeseville region, as already indicated, is one of tilted fault blocks; the major faults having a direction of about n. 30° e., while the minor faults trend north and south. The close resemblance of the layers throughout the unfossiliferous portion of the sandstone series caused considerable difficulty in the determination of the amount of displacement of the different faults and led to the exclusion, from the total estimate of thickness, of those beds the exact position of which could not be satisfactorily established.

The section of the chasm is through three blocks of sandstone of which the middle block has been dropped down between the north and the south blocks.

The north block with a thickness of 50 feet is of uncertain relation to the other two, so its thickness has been excluded from the total estimate.

The south block extending from Devil's Oven to Alice Falls has a thickness of at least 210 feet. The rock of this block is gray and white sandstone in layers of 2 inches to 3 feet thickness. Ripple-marks and cross-bedding are common. The only fossils found in the layers of this block were tracks of Climactichnites wilsoni which range through 10 feet of ripple-marked layers at a horizon about 90 feet below the top of the block. These layers are exposed at the top of the Birmingham fall at the head of the chasm.

The middle block with the highest beds of this section furnished the layers containing brachiopods, trilobites and gastropods. The thickness of this block as exposed to view is 245 feet. The lowest fossiliferous horizon is at 110 feet from the bottom of the block. This is a sandstone containing pebbles of

dolomite and shale and the shells of Obolella prima and Hyolithes primordialis (?).

Above the Hyolithes bed is a band of irregularly bedded sandstone limited above and below by bands of greenish argillaceous sandstone, and containing pebbles of brown shale and dolomite. This is the zone of Ptychoparia minuta and Conocephalites verrucosus, and holds, besides these species, Lingulepis minima, Lingulella acuminata, Obolella prima.

Above this zone Lingulella and Obolella occur at frequent intervals throughout 90 feet of the section to within 50 feet of the top. No other trilobite-bearing bed, and no gastropods were found at higher horizons in this section and we are led to think that the highest horizon of this Ausable section is below that of the Ophileta bed of the Potsdam at Kent Falls.

The total estimate of the thickness of the formation at this section must fall considerably below its actual thickness which probably will never be determined because of frequent and profound faulting. The measured thickness is at least 455 feet, of which a lower portion, 210 feet, is in the south block, and a higher portion of 245 feet in the middle block. Of this thickness the upper 110 feet contains the typical Potsdam fauna, without any indications of Siluric relationships. To this total may be added 15 feet, the thickness of the basal beds west of Keeseville, which brings the measured section, with exclusion of all doubtful beds, up to 470 feet.

Willsboro section

The Potsdam sandstone has been reported by J. F. Kemp and the late T. G. White (1894), as occurring in close proximity to the Beekmantown in the valley of the Bouquet river at the village of Willsboro, and on the shore of Lake Champlain near the mouth of the river. The exposures mentioned by the above authors were examined with the result that all the rock cropping out in the river near the village proves to belong within the limits of the Beekmantown series. Down the river, below the

village, this rock is exposed to the mouth of the river. Thence along the lake shore the Beekmantown is exposed in continuous outcrop for $\frac{3}{4}$ mile to the north side of Green bay where it is faulted against the Potsdam sandstone. From this point the Potsdam extends in continuous ledges along the shore for a mile northward to Flat Rock point, which point is incorrectly marked Jones point on the Willsboro sheet of the U. S. geological survey topographic maps.

The thickness of the Potsdam shown here is about 135 feet. The rock is in heavy and thin beds, many layers containing pebbles of shale which on exposure to the atmosphere result in the formation of cavities. Thin layers of greenish arenaceous shale are common. About the middle of the section is a layer, 152-A3, containing Lingulella and Obolella in abundance. No trilobites were seen.

This section seems to be about equivalent with the lower portion of the Kent Falls section.

Crown Point section

A section was examined along the track of the D. & H. R. R. near Burdick's crossing $1\frac{1}{2}$ miles north of Crown Point with the hope of finding some trace of the Potsdam sandstone beneath the lower layers of the Beekmantown. The search proved vain so far as finding the Potsdam was concerned, though the lower portions of the dolomite were found to be arenaceous. The section is 130 feet thick, with Ophileta toward the top of the series. An interesting intra-formational breccia occurs in the lower part of the section and chert beds toward the middle.

Summary of results

The area covered by the sections above described is of small extent when compared with that over which the Potsdam sandstone forms the surface rock to the north and northwest; the results obtained can, accordingly, have little more than provincial value and the conclusions drawn must be of a tentative nature till such time as they may be confirmed after field work over the adjoining districts. They will, however, serve to in-

dicate the lines along which future investigation should be carried on. It may be stated that a good beginning has been made toward the acquirement of a more precise knowledge of the Potsdam sandstone. The results are arranged in sequence under the numbers of the questions on p. 530 and p. 531 at the beginning of the report.

1 The base of the Potsdam has been seen to rest on the irregular surface of the pre-Cambric rocks, with a nonconformable contact, the nature of the contact being such as to indicate a period of long continued erosion. It is of interest to note that in some cases the materials composing the basal conglomerate have been transported from considerable distances and contain no fragments of the subjacent rock of the immediate vicinity. Such an instance is afforded by our basal sandstone, 150-E2, west of Keeseville, a good description of which has been already published by Cushing.

No formations of Cambric age have been found below the Potsdam in the area covered by this report. Certain hypotheses suggested by megascopic examination of the pebbles contained in many layers of the Potsdam can not be discussed till careful microscopic examinations have been made.

2 A possible indication of Ordovician relationship may be afforded by the presence of the genus Ophileta with Platyceras in the upper part of the Kent Falls section. More extensive collections should be made at this point.

In the area under discussion the transition beds between the Potsdam and Beekmantown are absent, both by cutting out along fault lines and by glacial erosion, drift-filled valleys extending parallel to the strike of the formation at those horizons where should be found the transition beds. Farther north in the towns of Champlain and Chazy where the strike is at right angles to the direction of movement of the continental glacier these softer beds of the uppermost Potsdam are exposed to view. They prove to change by slow gradations from sandstones with thin intercalated dolomites, through sandstones with thicker dolomites, finally merging into dolomites with

intercalated sandstone layers and eventually into the pure dolomites of the Beekmantown series. These facts are reserved for more detailed discussion in a future report.

3 No evidence obtained.

4 Certain physical characters have been found to be more characteristic of one portion of the formation than of another, and to some extent are useful as means of recognizing the different horizons.

The presence of feldspar grains appears to be restricted to the lower portion; if the feldspar be accompanied by other minerals, as magnetite, it may be taken for granted that the base of the formation is near at hand. Red and brown are more usually the colors of the lowermost portion. Coarseness of materials with little sorting of the grains according to sizes are also characteristic of this portion.

The middle portion of the sandstone is made up of well sorted materials, of finer grain, compactly cemented, and of white, steel gray, or yellowish color, with very little or no feldspathic content. The grains of sand are both angular and rounded with the former predominating. The layers are more regular though their surfaces are ripple-marked, and in section they are seen to be almost universally cross bedded. Pebbles are found on the surfaces of some layers of the middle portion, but unlike those of the upper portion they seem to have been of soft mud derived by erosion of contemporaneous sediments, cast on the beach at times of rough water and flattened and squeezed out by the subsequent pressure and consolidation of the superimposed sand deposits.

The upper portion of the formation has frequent beds of irregular laminated sandstone with partings of greenish arenaceous shale. The shale surfaces are covered with fucoids and worm trails. Pebbles of shale and dolomite, which were hardened before the time of their entombment, are found embedded in the sandstone layers, and their disintegration causes cavities to form in the layers containing them. The

dolomite pebbles become more abundant toward the upper horizons. Dolomite also occurs in thin beds intercalated between the layers of sandstone toward the higher levels, and in the uppermost horizons, as already mentioned under heading 2, gradually crowds out the sandstone. In the upper levels frequent beds are composed of nicely rounded grains of clear quartz with little cement, that crumble to a sugary powder under the hammer. Rounded grains of quartz of a slightly larger size occasionally cover the upper surface of a layer of finer grained sandstone, and being without cement, they stand out in relief above the surface with an appearance of having been sprinkled from a pepper pot. In other cases aggregations of noncemented grains have been found embedded within layers of heavy though porous beds, as in the case of the Hyolithes bed, 150–A3, in the Ausable chasm.

5 No fossils have been recognized in the lower portions of the formation. The middle portion has afforded only the Climactichnites tracks at the Birmingham bridge, and numerous irregular, unidentified worm borings and trails.

The upper portion of the formation holds fossils through a series of beds aggregating at least 350 feet in thickness. We have at present no evidence on the position of these fossiliferous beds in relation to the actual top of the formation. The list of fossils includes: trilobites, four species; brachiopods, three species; gastropods, three species; annelids, two species, and several undeterminable burrows and trails; fucoids, several; tracks, one species of Climactichnites.

To some extent these fossils may be arranged in zones. Such arrangement can only be tentative and will certainly need readjustment with the extension of the field work over a larger area. Two species of brachiopods, Lingulella acuminata and Obolella prima, seem to occur throughout the entire range of the fossiliferous horizons, as do also the fucoids and many worm trails and branching burrows.

Such zones as can be distinguished are arranged in the following sequence, "a" being the lowest.

a Climactichnites wilsoni Logan; lowest zone in midst of middle portion of sandstone.

b Hyolithes primordialis (?), Lingulella acuminata Conrad, Obolella prima Conrad.

b Scolithus linearis Hall; at Kent Falls only.

c Lingulepis minima Whitfield, Lingulella acuminata Conrad, Obolella prima Conrad, Ptychoparia minuta Whitfield, Conocephalites verrucosus Whitfield.

d Lingulella, Obolella, Conocephalites verrucosus, Ptychoparia small, trilobite with broad cheek, Ophileta compacta Salter (?), Platyceras, Scolithus canadensis Billings.

e Scolithus canadensis in abundance on the upper surfaces of sandstone layers of the transition beds in the uppermost portion of the formation. These uppermost layers have up to the present yielded no other fossils than this worm burrow.

6 No answer can at present be given to this question. Some suggestive evidence has been derived from the pebbles included in the layers of sandstone at various horizons in the formation. It is, however, of such disconnected character and meager amount as to warrant its exclusion from the present discussion.

THE GRAPTOLITE (LEVIS) FACIES OF THE BEEKMANTOWN FORMATION IN RENSSELAER COUNTY N. Y.

BY RUDOLF RUEDEMANN

La masse schisteuse de la vallée de l'Hudson, renfermant de nombreux graptolites, l'existence de ces fossiles sur l'horizon de la faune primordiale serait un fait particulier au continent americain et digne de la plus grande attention. Il resterait à etablir les relations, soit paléontologiques, soit stratigraphiques, entre ces graptolites de la vallée de l'Hudson et ceux de la Pointe Lévis, près Quebec.

BARRANDE. 1862

DESCRIPTION OF THE EXPOSURE

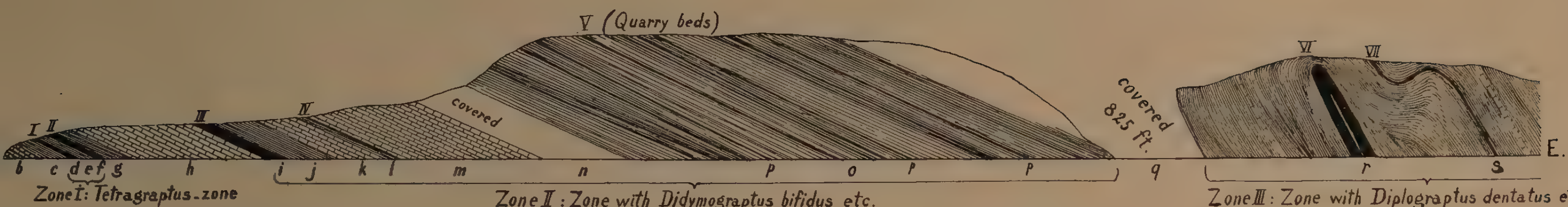
The section described in this paper is exposed along the Deep kill, a small eastern tributary of the Hudson river, and begins about a quarter of a mile east of the small settlement known as Grant Hollow in the northwestern part of Rensselaer county.

a In ascending the Deep kill valley from Grant Hollow, the first exposure is a small outcrop in the south bank of a few feet of deep black mudstone giving conchoidal fracture. This rock has furnished no fossils. Another outcrop, where are exposed somewhat contorted dark gray, sandy, thinly bedded shales with a few intercalations of argillaceous sandstone, is 30 feet farther up. These strata also proved to be barren of organisms.

The continuous section begins 700 feet farther east, on the north side of the creek. The beds of this exposure are, in contrast to those met with farther up and down the creek, free from flexures and dip uniformly N 116° E at an angle of 24°. It is apparent that the extremely heavy bedded, hard silicious beds and the limestones prevailing in this section protected the shales from being thrown into the many small, closely packed folds so characteristic of the softer and more pliable terranes of the region. There is no cleavage in these beds; and the slickensides, which often run subparallel to the bedding planes and obliterate or at least distort all organic remains in so many outcrops of the Trenton, Utica and Lorraine shales in the Hudson river region, are frequent only where the heavy quartzose banks have slipped along the thin shale partings. To the absence of these antagonists of the paleontologist the beautiful

Plate 2

Section along Deep Kill, Rensselaer co.



Legend: limestone shale graptolite bed

Scale, vertical and horizontal: 1 in. = 20 ft.

preservation of the graptolites in the Deep kill beds is largely due.

b At the base of the section (*see* diagram) are found 4 feet 9 inches of rock, consisting of rather regular alternations of thin limestones, with thinner layers of shale. These beds still show some irregularity of tilting. The limestone as well as the shale appears to be quite barren of organisms.

c Then follows a stratum, 2 feet 8 inches, consisting of rapidly alternating gray to reddish gray coarse grained sand-shales and dark, finer grained, highly silicious beds. The lower layers of the latter contain numerous small, angular pebbles of limestone and black hornstone in such quantities that these appear brecciated.

d This stratum is overlain by 8 inches of thin, dark greenish gray, hard silicious bands with thin intercalations of black shale. The latter contain graptolites in great number. This bed we connote as *graptolite bed 1.*

e Thin bedded shales and silicious layers; 1 foot 8 inches. The lowest is a thin limestone band; another is found near the middle. The silicious bands change in places to grits and breccias as in stratum *c*. Fossils seem to be absent.

f Greenish gray, hard silicious layers and intercalated deep black shales, forming a stratum which lithologically is like stratum *d;* 1 foot 9 inches. Like the latter, it carries graptolites in great profusion. Indeed, this bed has proved the richest of all in these fossils, and its graptolites are in the best state of preservation. It is here termed *graptolite bed 2.* The greenish quartzose bands are perforated in all directions by worm tubes and are covered by carbonaceous blotches apparently originating from seaweeds.

g Thin bedded, very hard, gray to black silicious beds, 2 feet 9 inches, overlie these graptolite shales. They are not separated by shale partings, and show no traces of organic life.

h Thin bedded, dark gray, hard limestone, with no indications of organisms but worm tubes; 14 feet 3 inches. The layers possess very uneven surfaces, as if deposited in turbulent water,

and also inclose a few intercalations of coarse arenaceous beds, of breccia bands and of shale. The last contains no graptolites and differs from the graptolite shale by its lighter color, coarser texture and more abundant arenaceous element.

i Greenish gray silicious beds with intercalated soft carbonaceous shale, the latter containing a considerable graptolite fauna; 2 feet. The shale is a little more sandy than that of the preceding graptolite beds; and the fauna, as shown by the lists of fossils, is so different that it heralds the appearance of a new zone. This is *graptolite bed 3*.

j Regular alternations of greenish gray, thinly laminated silicious layers and dark gray sandy shales; 5 feet 5 inches; no fossils. A thin seam of bluish black pyritiferous shale with a few graptolites was observed both near the bottom and top of the layers. The graptolites do not differ from those of bed 3.

k Dark gray limestone layers; 5 feet 9 inches. The limestone layers are thin, partly evenly bedded, partly exhibiting interlocking, narrowly undulating surfaces, very similar to those of the European triassic "Wellenkalk." There is here also a breccia 5 inches thick, with coarse sand as cement. The thin, shaly partings between the limestone layers contain no graptolites.

l Alternations of greenish silicious beds and black shales, with a 4 inch limestone breccia in the middle; 16 inches. Graptolites occur sparingly and in poor state of preservation in the shale. This *graptolite bed 4* has the characteristic species in common with bed 3.

m Limestones which exhibit the undulating character noted above still more strikingly; 16 feet. The thin shale partings between the limestone layers, as in all other limestone strata of the section, are destitute of graptolites.

n Covered; 8 feet 9 inches.

o This short break in the section is followed by the large exposure in the quarry lately opened to obtain the material for the construction of the dam of the Lansingburg waterworks.

There are exposed here 52 feet of hard, quartzose, fine grained and thin bedded layers, which however have become consolidated into compact banks averaging 2 to 3 feet in thickness. The thin bedding is indicated by the rapid alternation of darker greenish gray with lighter colored bands. These heavy banks are separated by extremely tenuous partings of carbonaceous shale, which are often densely covered with graptolites, mostly specimens of Phyllograptus. The graptolite layers of the quarry beds are, on the diagram, designated by heavier lines and the letter *p*. They constitute *graptolite bed 5*. By orogenic disturbances which have affected this region the blocks have been slipped along many of the partings and the organisms destroyed. In the silicious layers only worm tubes were noticed.

q Here ends the practically continuous section of the lower and middle graptolite zones, and for a distance of about 825 feet (figure obtained by pacing) no further exposures could be found.

r Then follows the large but temporary exposure afforded by the cutting into the north bank of the creek for the purpose of securing the north end of the dam. The length of this section was 135 feet. The prevailing rock of the exposure was greenish gray quartzite, similar to that of the quarry beds, but less compact and softer, with some brecciated layers and several thin bands of gray limestone interbedded with the greenish rocks. All these strata were however contorted in the manner mentioned before.

Two graptolite beds were found in this part of the section. The first (*bed 6*), 39 feet from the west end of the cut, forms the nucleus of a narrow steep fold consisting of 6 feet of a compact mud rock. As the bed is folded on itself, the actual thickness of the layer is 3 feet. 30 feet farther east 2 feet of a soft black graptolite shale were found (*graptolite bed 7*). On account of the disturbed position of the beds, the exact distance between the graptolite beds and the total thickness of the beds exposed could not be ascertained satisfactorily. The

great majority of the organic remains were obtained from the huge pile of rock material taken from the cutting and dumped a little farther down the creek.

The list of organisms collected in this last section will demonstrate that they belong to another and entirely different fauna, which represents a zone that in Europe has been found to succeed that of the quarry beds. It is, hence, safe to assume that the beds in the cut are a part of a terrane which overlies those exposed in the lower continuous section. In the latter there are exposed upward of 123 feet of rock. The beds in the dam cut, which is 135 feet long, may have reached 60 feet in thickness. Hence, even if the beds in the covered interval of 825 feet (which, taking account of the dip, would represent an approximate maximum of 336 feet) were repeatedly folded on themselves, they would easily reach 100 feet in thickness, and the rocks of all three zones, from the west to the east end of the section must have attained a total thickness of 200 to 300 feet.

The investigations carried on by Prof. T. Nelson Dale in the slate belt of Vermont and eastern New York in the region to the north of the Deep kill have shown the occurrence in a number of localities of "dark gray calcareous or very quartzose, finely bedded shales or black shales with thin limestone beds immediately overlying the ferruginous quartzite" which is considered of Cambric age.[1] It is added that these "are easily overlooked on account of their inconspicuous characteristics and their inconsiderable thickness." In the table facing p. 178, the latter is given as 35 + feet. Graptolites found in these shales were referred to Dr Gurley and determined as follows: Bryograptus, Dichograptus, Callograptus salteri? *cf.* Dendrograptus *sp.* and Dictyonema flabelliforme, and it was concluded that "several of these are regarded as probably of Calciferous age." The genera identified indicate that either the beds observed in these localities may be identical with those of one of the Deep kill zones,

[1] Slate belt of eastern New York and western Vermont. 1899. p.185.

viz, the lowest, which then would appear to rest directly on Cambric beds; or that they may, as suggested by the reported identification of Dictyonema flabelliforme, belong to an upper Cambric or transitional zone, and that the Cambric may, therefore, be also represented in this slate belt by graptolite shales. The fact that the middle and upper zones found at the Deep kill seem to be absent in the outcrops referred to by Dale, may also account for the small thickness of the terrane reported by that investigator, as compared with that found at the Deep kill.

A striking feature of the Deep kill section, and one worthy of special notice, on account of the still contested nature of the habitat of the graptolites, is the regular periodic succession of the rocks associated with the black graptolite shales within the two lower zones. To demonstrate these cycles of deposition, the list of the beds is given in a more comprehensive form.

b *limestones* with shaly intercalations
c sandy shales and grits
d greenish silicious shale and black *graptolite shale*
e thin bedded shales, grits and *limestone*
f greenish silicious shale and black *graptolite shale*
g greenish silicious shale
h *limestone*
i greenish silicious beds and black *graptolite shale*
j greenish silicious beds and sandy shales
k *limestone*
l greenish silicious beds and black *graptolite shale*
m *limestone*
n covered
o greenish silicious beds and black *graptolite shale*

It will be noticed that the deep black, soft graptolitiferous mud shales are always inclosed in greenish gray, very hard, thin bedded, more quartzose layers, and that between two periods of deposition of these there is always intercalated one of thin bedded, barren limestone. This alternation is presented five times in the section.

It has also been observed at other graptolite localities, for example, the Normans kill shale on the north side of Mt Moreno near Hudson, that the graptolite-bearing shale was enveloped in greenish, hard silicious beds. The close stratigraphic connection existing between these greenish and the graptolite shales, and the absence of graptolites from the lithologically similar black shale partings of the calcareous layers indicate that both the former originated under closely similar conditions. It suggests itself that the only change in the physical conditions was in the swiftness of the current, the silicious beds being deposited in a current which carried more material, while a slackening of the current allowed the slow deposition of the fine argillaceous and carbonaceous mud which entombed the graptolitic detritus. That the latter, in most of the Deep kill beds, can not have been exposed to any turbulent wave or current action, is clearly evinced by the retention of the most delicate parts like the hydrocaulus. It is further clear that the graptolites did not live continuously on the bottom where they are now found, for they appear only intermittently and then in vast multitudes and always in different associations. The aspect of the paper-thin seams changes kaleidoscopically from seam to seam; and often a surface will present nothing but the spawn or only a certain growth stage of a single species. These conditions of deposition, and similar ones in the Trenton and Utica zones argue that the fauna was, from time to time, carried into this coastal region of the sea from an outside and presumably pelagic region.

The limestones which form considerable banks between the graptolite beds are evidently not direct organic deposits or shell heaps, but were either derived from the abrasion of a calcareous coast which furnished the fine calcareous mud, or were direct chemical deposits such as are formed wherever decaying organic matter furnishes the necessary carbonate of ammonia to form calcium carbonate out of the gypsum contained in the sea water. As the carbonaceous mud partings between the calcareous layers indicate an oft-repeated interruption of the

process of calcareous sedimentation, it is more probable that the calcareous mud was derived from the coast and was also brought into that neighborhood by the motion of the water. In taking account of all observed changes of deposition in the Deep kill section, it is fairly safe to conclude that an alteration in the direction of the movement of the water caused either the calcareous or the silico-argillaceous mud to be deposited.

The fine grained shaly partings between the beds were formed during a period of quietness; but, while these partings of the limestone beds are barren, those of the silico-argillaceous mud beds are covered with graptolites; hence, at the period when the currents brought the calcareous deposits and during the intervening shorter calms, the higher levels of that part of the sea were free from graptolites, while at the period when the silico-argillaceous mud was brought in, the sea swarmed with them.

In an excellent exposition[1] of the probable conditions of life of the graptolites, Lapworth has concluded that the fine grained black graptolitiferous sediment may have been deposited either in shallow or in deep water and that its formation depended not so much on depth as on the quietness of the water. The conditions under which the Deep kill graptolite beds appear to have been deposited seem in full accordance with this inference, and from the character of the sediments in that section as described above, it also appears that the direction of the flow of the water, which precluded the period of quietness or which continued in the higher levels of the sea must have been on the whole shoreward from the open sea, which latter undoubtedly was the habitat of the graptolites. Thence they came either as holo-planktonic free floating organisms or as pseudo-planktonic, fastened to seaweeds of the character of the recent sargasso, as argued by Lapworth.

The water from which the graptolites were settling was not altogether free of current movement, as is shown by the parallel

[1] Zeitschrift der Deutsch. geol. Gesellschaft. Jahrg. 1897. Heft 2, p. 239 ff.

direction in which the specimens lie in some beds. But it was always a very gentle flow, as otherwise neither the very fine mud nor the graptolites themselves could have been deposited thus.

GRAPTOLITE ZONES OF THE DEEP KILL SECTION

A. Tetragraptus zone

Graptolite bed no. 1

The first graptolite fauna of the section occurs in bed *d* and is characterized by the prevalence of representatives of the genus Didymograptus, notably of Didymograptus patulus, the colonies of which are found in great profusion on every slab from this bed. The entire faunule of bed *d* consists of the following forms:

1	Callograptus salteri *Hall*	rr
2	Bryograptus *sp. nov.*	c
3	Dichograptus octobrachiatus *Hall*	rr
4	Tetragraptus serra *Brong.* (=T. bryonoides *Hall*)	r
5	Tetragraptus bigsbyi *Hall*	c
6	T. fruticosus *Hall*	c
7	T. *sp. nov.*	r
8	Didymograptus nitidus *Hall*	c
9	D. patulus *Hall*	cc
10	Phyllograptus ilicifolius *Hall*	r
11	P. angustifolius *Hall*	rr
12	Dawsonia monodon *Gurley*	c
13	Caryocaris *sp.*	c
14	Small oboloid and linguloid brachiopods	cc
15	Small indet. gastropods	r

Graptolite bed no. 2

The next faunule is that of bed *f*, which is separated from the preceding by only 1 foot 8 inches of barren layers. This graptolite bed, with a thickness of 1 foot 9 inches, proved not only extremely rich in number of species and specimens, but specially valuable on account of the excellent state of preservation of

the latter, which are highly lustrous and clearly had not been exposed to any maceration before becoming embedded. This bed must be regarded as a veritable treasure chamber, as it contains numerous perfect colonies which are neatly spread out on the surfaces of the slabs and retain all parts, the central disk, sicula and virgula; and some species occur in all their growth stages. In one layer, a great number of the specimens are pyritized, specially so the numerous hydrosomas of Phyllograptus ilicifolius and of the dichograptids. This material will allow an investigation into the structure of these forms.

The writer abstains in this publication from describing the numerous forms which are not identifiable with species hitherto known on this continent, partly because time has not yet allowed a satisfactory illustration nor a thorough comparison with related species known from foreign graptolite shales; and partly because a monograph of the graptolites of New York is thought to furnish a more appropriate receptacle for such descriptions.

The following is a list of the species found in graptolite bed 2:[1]

1	Dendrograptus *sp. nov. Hall*	r
2	D. cf. gracilis *Hall*	r
3	Dictyonema *sp. nov.*	r
4	Callograptus salteri *Hall*	r

[1] The peculiarity of most graptolite beds, that the separate layers of the same bed differ in the relative prevalence of certain species and hence in the general aspect of the assemblages, is strongly marked in this; certain layers are nearly covered with specimens of a new Bryograptus, others with those of the various tetragraptids and again others with the branches of dichograptids. Fossil lists of the faunules of these thin layers fail, however, to bring out a difference in their composition, or in the number of species. It appears, therefore, that all these different assemblages lying so close together in the rock, were derived from contemporaneous denizens of the sea. These graptolites either lived together in shoals, or more probably, while slowly settling, became separated according to their size and weight.

If, therefore, a form as Bryograptus *sp. nov.* is listed as extremely common (ccc) this statement does not refer to all layers of the bed, but only to one or to a few.

5	Bryograptus *sp. nov.*	ccc
6	B. kjerulfi *Lapworth*	rr
7	Loganograptus logani *Hall*	ccc
8	Dichograptus octobrachiatus *Hall*	ccc
9	Goniograptus thureaui *McCoy*	cc
10	Goniograptus *sp. nov.*	r
11	Temnograptus *cf.* multiplex *Nicholson*	c
12	Tetragraptus fruticosus *Hall*	cc
13	T. fruticosus *var. nov.*	c
14	T. serra *Brong*	cc
15	T. bigsbyi *Hall*	cc
16	T. quadribrachiatus *Hall*	cc
17	T. *aff.* hicksii *Hopk.*	r
18	T. *sp. nov.*	r
19	T. *sp. nov.*	r
20	Phyllograptus ilicifolius *Hall*	cc
21	P. angustifolius *Hall*	r
22	Didymograptus nitidus *Hall*	c
23	D. patulus *Hall*	cc
24	D. extensus *Hall*	cc
25	D. filiformis *Tullberg*	r
26	D. (Leptograptus) *sp. nov.*	c
27	Dawsonia tridens *Gurley*	c
28	D. monodon *Gurley*	c
29	Caryocaris curvilatus *Gurley*	cc
30	*Cf.* C. oblongus *Gurley*	r
31	Small indet. brachiopods	cc

A comparison of the fauna of graptolite beds 1 and 2 proves that both belong to the same zone. This zone is characterized by the prevalence of species and individuals of the genera Dichograptus, Tetragraptus, Didymograptus and Phyllograptus. Of these the genus Tetragraptus appears with the greatest number of species, and it clearly reaches the acme of its development here. While T. quadribrachiatus and the new species have not been observed to pass into the higher zones,

the other species are represented in the latter only by dwarfed mutations. The term "Tetragraptus zone", which has been proposed for the corresponding zone in the Skiddaw beds of England, appears, therefore, to be also quite appropriate for the American graptolite zone.

Among the species of Didymograptus it is a striking phenomenon that only the forms with horizontally extended branches are present, while the "tuning fork" species, so characteristic of the middle Lower Siluric zones of Europe, are still entirely absent. Goniograptus thureaui also extends into the next zone, but does not there attain the size of its ancestors. The genus Phyllograptus attains its largest size (Ph. typus) and its greatest number of species only in the next horizon.

Nearly all the species of this fauna, which bear Hall's name as that of their author, were described[1] as coming from the "shales of the Quebec group, Point Levis." While Hall in these important papers did not enter on a discussion of the age of the graptolite shales of the Quebec group, he correlated, in the table showing the vertical distribution of the graptolites (*loc. cit.* p.55), the Quebec group with the Calciferous and Chazy periods, thus placing these graptolite beds in a general way near the base of the Lower Siluric. Nor did he attempt to separate the graptolite fauna of the Quebec group into its constituent zonal faunules, but from the associations which he mentions in the descriptions of the species the presence of two different faunas, that of Point Levis and that of the St Anne river, is clearly apparent. These two faunas were differentiated as the Point Levis zone and the River St Anne zone by Lapworth,[2] and the latter zone, in accordance with the succession established in England, is placed above the former.

Later, the same distinguished investigator of the graptolites studied[3] collections from the lower paleozoic rocks on the south

[1] Geol. sur. Canada. Rep't for 1857; and fig. and descr. Can. org. rem. Decade 2. 1865.

[2] Ann. and mag. nat. hist. 1880. 5th ser. 5:275.

[3] Roy. soc. Canada. Proc. and trans. 1886. 4:167 ff.

side of the St Lawrence river. These contained only the association characteristic of the next higher Deep kill zone, and it was placed provisionally in the Chazy. Lapworth added that there are certainly several zones at Point Levis, and that, by analogy with the English series, he would place the zone last named at about the middle of the series. This conclusion is fully verified by the actual succession of the zones in the Deep kill section.

A very thorough account of the history of the problem of the Quebec terrane has been given by R. W. Ells,[1] accompanied by extensive fossil lists from all outcrops of the Quebec region, prepared by Dr Ami. The succession of the larger divisions of the Quebec terrane is therein clearly set forth. Dr Ells concludes in this paper that the evidence afforded by the stratigraphy and by the graptolites determined by Prof. Lapworth, is sufficient to refer the Sillery rocks (1–4) to the Cambric system, and the Levis beds (5) to the lower Ordovician. He suggests that the term "Levis" be used for the local development of the Calciferous (Beekmantown) terrane about Quebec. These Levis beds measure, according to Logan, about 2000 feet in thickness. As the Deep kill beds contain the greater part, if not all, of the graptolites which have become known from the Levis beds, they represent a southern continuation of the same, or, more exactly speaking, of the graptolite shales contained in the Levis beds; for the conglomerate bands of the Levis region with their interesting fauna, both in the matrix and boulders, are apparently wanting here.

In reviewing Dr Ells's report, Mr Walcott[2] states that in 1889 he found together with Dr Ells the typical Calciferous fauna in the matrix of the conglomerate bands in the Levis beds, while the boulders contain the Potsdam fauna. The mixing of these two large faunas has been the cause of much of the confusion and mystery surrounding for so long a time this part of the Quebec terrane.

[1] Geol. nat. hist. sur. Canada. Rep't 1888. 2d ser. v. 3, pt 2, 12 k ff.
[2] Am. jour. sci. 1890. 3d ser. 39:101 ff.

The results of these investigations leave no doubt that the *Tetragraptus zone of the Deep kill section*, which is identical with one of the Point Levis zones, *is* properly to be regarded as *a graptolite facies of the Beekmantown or Calciferous period.*

No attempt was made by Dr Ells to separate the various graptolite zones of the Levis beds. Later, it was stated by Ami[1] that there exist well marked zones in different portions of the series of the Levis strata, but their separation was not carried out. It is, therefore, evident that the complicated stratigraphic conditions under which the Levis beds are found in the Quebec region do not invite or permit an establishment of the succession of their faunal zones.

An attempt to accomplish this, however, by reference to the well known succession in Europe, has been made by Dr R. Gurley.[2] Dr Gurley states that he had the opportunity of studying two different collections, with different faunas, from the Point Levis shales. One of these, coming from a black shale, with Dichograptus flexilis and Phyllograptus ilicifolius var. as conspicuous members, is termed the *Main Point Levis zone* and tentatively placed in the Lower Calciferous. It is with the fauna of this zone that the assemblage described above as characterizing the lowest beds of the Deep kill section, or those of the Tetragraptus zone, is identical.

Mr G. F. Matthew has reported[3] the occurrence of the zone with Dichograptus logani and Tetragraptus quadribrachiatus, etc. in the St John basin, separated from the Cambric zone of Dictyonema flabelliforme by several hundred feet (175?) of shales whose fauna is unknown. As the other zones seem to be absent in that region, it does not furnish any clue to the stratigraphic relations of the Levis zones.

A more exact determination of the position of this zone in the series of paleozoic formations has been possible in Scandinavia and Great Britain. In England, the graptolite fauna

[1] Geol. soc. Am. Bul. 1890. 2: 492.

[2] Jour. geol. 1896. v. 4, no. 3, p. 302.

[3] Can. rec. sci. Oct. 1891; p. 3; Nat. hist. soc. Bul. 10, p. 3.

of the lower part of the Skiddaw slates in the Lake district has for a long time been known to have more species in common with that of the Quebec shales than with the other English graptolite faunas. Nicholson and Lapworth described numerous forms from these interesting beds and concluded that the lower Skiddaw slates, or the zone of Tetragraptus bryonoides, corresponds to the principal zone of the Quebec beds, which is the Main Point Levis zone of Gurley. These lower Skiddaw slates they considered as contemporaneous with the lower Arenig, and therefore placed the zone near the base of the lower Siluric.

Lately, the graptolite fauna of the Skiddaw slates has been carefully investigated by Miss G. L. Elles.[1] Miss Elles concludes that the Skiddaw slate fauna, "though it is more closely related to the fauna of the Quebec group of Canada than to that of any English beds, is still more nearly related to the Swedish fauna; for, while of the whole 59 species, 25 are common to the Skiddaw slates and the Quebec, and only 14 common to the Skiddaw slates and the two other English areas, no less than 34 species are common to the beds of Sweden and the Skiddaw slates." The fact of the greater resemblance of the Skiddaw and Swedish faunas can not be held, however, to vitiate the conclusion of the homotaxy of the Quebec or Levis and of the Skiddaw zones; for it is only natural that, in homotaxial beds the English and Swedish faunas which flourished in closely adjoining geographic regions should have more forms in common than the Skiddaw and the far distant Levis faunas. The writer believes that, considering the great difference in relative distances, the great number of forms which are common to the Skiddaw and Levis beds, and which comprise one half of all the Skiddaw species, is as conclusive proof of the homotaxy of these latter beds as the greater number of common species is of the English and Swedish beds. This argument is aided by the consideration that the Levis fauna has not by far been as thoroughly studied as the Skiddaw and Swedish faunas, because

[1] Quar. jour. geol. soc. 1898. 54: 463 ff.

Prof. Hall had not as complete collections at hand as were gathered by the numerous English and Swedish collectors and that nearly all Levis forms were found in the Skiddaw slates; that hence, vice versa, a more thorough investigation of the Levis beds would bring to light still a considerable number of species at present known only in England and Sweden. In fact, the provisional identification of the faunas collected at the Deep kill points already to an increase of the forms common to both continents. Furthermore, it is just these most characteristic forms that are common to the Skiddaw, Swedish and Levis faunas. Finally, the discussion of the next two succeeding graptolite zones of the Deep kill section will show that their succession, and hence most probably also that of the Quebec zones, is identical with that of the Lake district and Scandinavian zones. This parallelism of the succession of the zones can, however, be construed to mean only that these faunas occupied these vast territories contemporaneously and in the same succession.

The complete list of graptolites of the Skiddaw slates given by Miss Elles (*loc. cit.* p. 526-27) indicates that the fauna of the Deep kill zone, here under discussion, *corresponds to a part of the fauna of the middle Skiddaw slates or Arenig.* These middle Skiddaw slates have again been subdivided by Nicholson, Marr[1] and Elles. Miss Elles divides them into the lower Tetragraptus bed, the Dichograptus bed and the upper Tetragraptus bed. As no lists of the faunules of these subdivisions are furnished, a final correlation of the Deep kill Tetragraptus zone with any of these subzones would be inadvisable at present. But the facts that the species of the multiramose dichograptids of the genus Clonograptus,[2] so common in the Main Point Levis beds, are absent in the Deep kill zone and represented by Goniograptus, a type of evidently later development; and that the younger genus

[1] Geol. mag. 1894. 4th ser. 1: 122.

[2] In connection with the peculiar absence of species of Clonograptus may be pointed out the equally peculiar presence of two species of Bryograptus, a distinctly Cambric genus; one of these with a profusion of individuals.

Dichograptus *sensu stricto* is greatly predominant, would indicate that there may exist in the Main Point Levis zone a still older subzone, carrying principally these species of Clonograptus, and which is not exposed in the Deep kill section. The latter subzone would then correspond to the lower Tetragraptus beds, and *this Deep kill subzone to the Dichograptus beds.* This correlation is supported by the fact, that the next Deep kill zone is homotaxial with the upper Tetragraptus beds.

The investigations of Hopkinson and Lapworth[1] have demonstrated that the characteristic fossils of this zone occur also in the Arenig series of St Davids in Wales, of Shelve in West England, and in the Ballantrae terrane, underlying the Moffat series in south Scotland.

The most detailed division of the graptolitiferous beds and the most exact correlation with the limestone facies have been attained in southern Sweden where the paleozoic beds, as a rule, lie horizontal. It is only necessary to cite the names of Linnarsson, Törnquist and Tullberg to indicate the refined division in zones of the Siluric in that country, which now has become common property by its adoption in textbooks.

Linnarsson[2] comprised under the name *lower Graptolite schists* (or *Phyllograptus schists*, as proposed by Dr Törnquist) all the graptolite-bearing strata that lie between the Ceratopyge and Orthoceras limestones. Their fauna consists of the Dichograptidae and their closest ally the Phyllograptidae. He points out that the most abundant species are identical with or representative of those familiar to us in the Skiddaw and Quebec groups, such as Didymograptus patulus, constrictus, indentus, etc., Tetragraptus quadribrachiatus, bryonoides and bigsbyi. There can be, hence, no doubt *that this zone is identical with the lowest Deep kill zone*, called the Tetragraptus zone in this publication.

---

[1] *See* specially Ann. and mag. nat. hist. 1879. 5th ser. 2: 4, and Geol. mag. 1889. 3d ser. 6: 20, 59.

[2] Geol. Fören. Förhandl. Stockholm. 1879. no. 8, p. 227 ff.

Tullberg[1] divides F, his Understa etagen, into

a Zone with Phyllograptus *sp.*

b Orthoceras limestone

c Tetragraptus shales (lower Graptolite shales)

d Ceratopyge limestone

The *Tetragraptus zone of the Deep kill section* or the Main Point Levis zone of Gurley, *is homotaxial with Tullberg's zone of the Tetragraptus shales.* As we shall see presently his zone *a*, the *zone with Phyllograptus sp.*, is also represented in the Deep kill section.

In the region of Christiania in *Norway* the presence of the fauna of the Tetragraptus zone has been demonstrated by Kjerulf (his "lower Graptolite shales") and Brögger ("Phyllograptus shales," in *Die silurischen Etagen 2 and 3*, etc. 1882. p. 18 ff). They found this Phyllograptus shale (3b) between the Ceratopyge limestone (3a γ) and the Megalaspis limestone (3c a).

Holm[2] obtained species of the Tetragraptus zone, such as T. bigsbyi and Phyllograptus angustifolius from glauconitic gray Orthoceras limestone (Planilimbata limestone) of Oeland and partly based on these his beautiful investigations regarding the morphology of these graptolites.

In *France* the following species, originally described from the Levis beds, Didymograptus pennatulus, D. nitidus, D. bifidus, D. indentus, Tetragraptus serra and T. quadribrachiatus, have been reported by Barrois[3] from the graptolite schists of Boutoury near Cabrières in the Languedoc. He correlates this schist with the middle Arenig (Skiddaw) of England, the Quebec beds of Canada and *étage* D d 1 β of Bohemia.

In the succeeding year the same distinguished author announced the discovery of the species described by Hall as Graptolithus richardsoni at La Mouchasse du

[1] Skanes Graptoliter I, in Sveriges Geologiska Undersökn. 1882. ser. C, no. 50.

[2] Sveriges Geologiska Undersökn. 1895. ser. C, no. 150.

[3] Annales de la Société Géologique du Nord. 1892. t. 20, p. 75 ff.

Temple (Cabrières), making it the type of the new genus Rouvilligraptus. As this species has to the writer's knowledge been found only in the St Anne beds, which are identical with the Deep kill zone (Did. bifidus zone) to be described next, it appears that both the Tetragraptus and the Didymograptus bifidus zones (St Anne beds) may be present at Cabrières.

From the auriferous shales of *Victoria, Australia*, Etheridge jr[1] has reported the occurrence of such well known Levis fossils as Tetragraptus bryonoides (=serra), T. quadribrachiatus, T. fruticosus, Phyllograptus typus, Loganograptus logani and Didymograptus nitidus, to which McCoy[2] has added Goniograptus thureaui. This list indicates the presence of the Tetragraptus zone in Australia.

The preceding brief review of a number of publications which announce the presence of the Tetragraptus fauna is sufficient to demonstrate the vastness of the area which it once occupied. Prof. Frech[3] has suggested the probability that there existed four grand marine provinces in the Lower Siluric which were more or less separated from each other, viz the Bohemian-Mediterranean, the Baltic, the North Atlantic and the Pacific-North American basins. The former existence and extension of these provinces is deduced from the comparative study of the horizontal distribution of the faunas, specially of their trilobite element. The graptolites however are expressly excepted as passing beyond the boundaries of these basins, and this phenomenon is explained by their pelagic or abysmal habitat in contrast to the littoral or shallow sea habitat of the provincial faunas. This necessity of contrasting the graptolite faunas with the other faunas on account of their vast geographic distribution, together with the well known fact of their short vertical range, is a conclusive demonstra-

[1] Ann. and mag. nat. hist. 1874. 4th ser. 1:41.

[2] Geol. surv. Victoria. Prodr. pal. Victoria. Decade 5, 1877. p. 39.

[3] Lethaea palaeozoica. 1897. 2:88 ff.

tion of their invaluable aid in exactly correlating parts of the Siluric system regionally widely separated. In the case of the Tetragraptus fauna, the precise determination of its position in the Beekmantown formation will permit a perfect correlation of that part of the Beekmantown formation with the highly subdivided Lower Siluric of northern Europe. Furthermore, as the graptolites changed so rapidly, and pelagic forms are not subject to the slow migrations of the littoral forms, but spread rapidly over wide territories, it is proper to conclude that this Tetragraptus fauna, like the succeeding faunas, conquered its territory in a very short time, and that we have here, hence, not only homotaxial, but actually synchronous beds of both hemispheres before us.

The fact mentioned above, that the English and Swedish faunas of this horizon have a greater number of species in common than they have with the Levis fauna, is, in this connection, worthy of special notice, as it proves that a world-wide and absolute identity of the pelagic graptolite faunas does not exist. This may indicate that there also existed geographic or regional differences, which, however, did not coincide with the differences in the distribution of the other fossil organisms, as has been suggested by Frech (*loc. cit.* p. 116) in view of the discrepancies observable in the succession of the two detailed series of upper Siluric graptolite zones, made out by Tullberg in Sweden and by Barrande in Bohemia.

Zone with Didymograptus bifidus and Phyllograptus anna

Graptolite bed 3

This bed has a thickness of 2 feet, and is separated by 14 feet of mostly barren limestone beds (bed h) from graptolite bed 2. It has furnished, partly in an excellent state of preservation, the following forms:

1	Dendrograptus *cf.* divergens *Hall*	r
2	Dictyonema *cf.* delicatulum *Dawson*	r
3	Callograptus salteri *Hall*	r
4	Dichograptus octobrachiatus *Hall*	r
5	Goniograptus thureaui *McCoy, var.*	c

6	G. *sp. nov.*	cc
7	Coenograptid *gen. nov. et sp. nov.*	c
8	Tetragraptus serra *Brong.* small mut.	c
9	T. bigsbyi *Hall* small mut.	c
10	T. fruticosus *Hall* small mut.	cc
11	T. pendens *Elles*	rr
12	Didymograptus *cf.* similis *Hall*	r
13	D. bifidus *Hall*	cc
14	Phyllograptus typus *Hall*	c
15	P. anna *Hall*	cc
16	P. angustifolius *Hall*	c
17	Nemagraptus *sp.*	r
18	Thamnograptus anna *Hall*	c
19	Lingula quebecensis *Billings*	rr
20	Small indet. brachiopods	cc

To this zone belong also the beds j, k, l, m and n, hard greenish silicious beds, sandy shales and limestones. Bed j bears, on black shaly partings, Didymograptus bifidus, the most characteristic form of this zone. The thin graptolite bed 4 in bed l also furnished this species and a few poorly preserved fragments of some of the other forms.

Graptolite bed 5

Under this notation have been united the numerous shaly partings between the heavy banks of greenish gray, extremely hard, silicious rock which is exposed, with a thickness of 52 feet, in the quarry at the east end of the continuous section (stratum o; the shaly partings are denoted on the diagram by the letter p). Most of these partings are covered to the exclusion of other species, with the rhabdosomes of the species Phyllograptus typus, Ph. ilicifolius (large mutation) and Ph. anna. The largest specimens of Phyllograptus typus occur however in a layer at the base of graptolite bed 3. The full list of the species observed in the quarry is:

1	Tetragraptus quadribrachiatus *Hall*	c
2	T. serra *Brong.*	r

3 Didymograptus bifidus *Hall* cc
4 D. similis *Hall* c
5 Phyllograptus typus *Hall* ccc
6 Ph. ilicifolius *Hall* cc
7 Ph. anna *Hall* c

The faunules of the graptolite beds 3-5 receive their characteristic aspect from the new appearance and abundance of individuals of Phyllograptus typus, Ph. anna, Didymograptus bifidus, D. similis and Thamnograptus anna. The last four were, together with Tetragraptus fruticosus, described by Hall as occurring in the "Quebec group, 3 miles above the river St Anne." They pertain, hence, to an association not known to him from the Levis region, nor have they, to the writer's knowledge, been reported since from the Levis beds, with the exception of Didymograptus bifidus, which is listed by Ami (Geol. surv. Can. Rep't for 1887–88, 53 k) as found in an excavation near the City hall of Levis and by Gurley as occurring also in another Levis zone identical with the next succeeding Deep kill zone. Lapworth found Phyllograptus anna associated with some other species, which are common to this and the Tetragraptus zone, in the collections submitted to him from the south side of the St Lawrence river, and termed this the *St Anne zone or zone with Phyllograptus anna*. He correctly supposed it to belong to about the middle of the series of the Levis zones. Dr Gurley, in compiling the list of the North American graptolites, had no collection from the St Anne beds to refer to, and cites only the forms listed by Hall and Lapworth.

Though the fauna of this zone, as well in the shales of St Anne des Monts, as in the Deep kill beds, appears rather limited when compared with that of the preceding zone, it is notwithstanding of the greatest interest, first stratigraphically, as it clearly marks a distinct horizon or zone, which is also discernible in very distant regions, and secondly phylogenetically, as it indicates the approaching suppression of the

dichograptid graptolite stock. The latter fact finds its strongest expression in the remarkable restriction in the number of species of dichograptids, but is also recognizable in the character of the species remaining. Of the multiramous dichograptids only Goniograptus is left, which, as will be shown in another article, has here become so fixed and unchangeable in the number of its branches that it is clearly a final derivative of the freely branching older Clonograptus forms. The species of the genus Tetragraptus, which latter reached the acme of its development in the preceding zone, are, with the exception of T. quadribrachiatus, crucifer and alatus, still present, but are represented only by smaller mutations. The genus Didymograptus, which lived into the Trenton period, and with a few species of its subgenus Leptograptus even extends into the Utica period, appears with two new species, which are restricted to this zone, and one of which, Didymograptus bifidus, is in the Deep kill section the most characteristic species of the zone, as it is extremely common in the beds, extends neither above nor below the zone and is the first of the "tuning fork" species of the genus, which in Europe are quite characteristic of still higher zones. The genus Phyllograptus attains in this zone in Ph. typus its greatest size and variability within the boundary of a species but is also represented by the diminutive Ph. anna, which also extends into the next zone and foreshadows or closes the life history of this peculiar genus. Finally there appears in this zone the first of the coenograptids, which attain their full development not before the middle part of the Champlainic or Lower Siluric.

Lapworth[1] reports a similar association, characterized by Didymograptus bifidus, D. extensus, Phyllograptus typus, Tetragraptus bryonoides and T. quadribrachiatus from the "Ballantrae rocks" in Ayrshire, south Scotland. Miss Elles lists Didymograptus bifidus as occurring in the middle and upper Skiddaw

[1] Geol. mag. 1889. 3d ser. 6: 22.

slates. In the latter (Ellergill beds) it is, however, reported to be associated with forms which are characteristic of the next higher Deep kill zone, while the species, associated here with D. bifidus, specially Phyllograptus typus and P. anna, are according to Miss Elles found there in the middle Skiddaw slates. In regard to this association it is stated (*loc. cit.* p. 529): "Tetragraptus serra (Brong.) and other forms are also found associated with the fauna which in Sweden characterizes the zone of Phyllograptus *cf.* typus and occur on the same slab as the earliest tuning fork Didymograpti." This association forms the *upper Tetragraptus subzone* (corresponding to the upper Arenig) *with which we have to correlate the present Deep kill zone or the St Anne beds of Canada.*

In *Scania* the zone with Phyllograptus *cf.* typus and Didymograptus *cf.* bifidus forms, according to Tullberg, the highest part of the lower Graptolite shale and overlies the Orthoceras limestone (limestone with Megalaspis planilimbata and Megalaspis limbata). But, as this zone is also reported to contain Climacograptus and Cryptograptus, which here do not appear till the next zone, this Scanian and the Deep kill zone can not be exactly parallelized; and it is to be assumed that the former holds a position intermediate between this and the next Deep kill zone, and that the *St Anne beds are homotaxial with the Megalaspis limestone itself.*

In *Bohemia* a form from *étage* D d 1 γ has been identified with Didymograptus bifidus by Dr Perner;[1] and in France, as noted before, Didymograptus bifidus and Rouvilligraptus richardsoni, two species of the St Anne beds, have been reported from the graptolite shales of Cabrières. Finally, the zone with Didymograptus bifidus was recognized by T. S. Hall[2] as a separate horizon in the auriferous shales of Victoria in Australia, where it also overlies the Tetragraptus zone. It appears that in Australia and New

[1] Etudes sur les Graptolites de Bohême. 2ième partie. 1895. p. 23.

[2] Austr. ass'n adv. sci. 1893. 5: 374.

Zealand the entire Lower Siluric is represented by graptolite shales with forms of world wide distribution.

Zone with Diplograptus dentatus and Cryptograptus antennarius

In the exposure produced by the construction of the dam of the Lansingburg waterworks two graptolite beds were noticed:

Graptolite bed 6

This bed contained, embedded in a massive dark mud rock:

1 Phyllograptus angustifolius *Hall*	c
2 Ph. *sp. nov.*	c
3 Diplograptus dentatus *Brong.*	r
4 Retiograptus tentaculatus *Hall*	c
5 *Cf.* Trigonograptus ensiformis *Hall* (fragments)	r

A larger fauna was obtained from

Graptolite bed 7

This bed consists of soft, black shale, the bedding planes of which are profusely covered with specimens. It furnished the following fauna.

1 Dendrograptus *sp. nov.*	c
2 Dictyonema *sp. nov.*	cc
3 D. *sp. nov.*	c
4 D. (Desmograptus) cancellatum *Hopk.*	c
5 D. (D.) *sp. nov.*	c
6 Callograptus diffusus *Hall*	r
7 C. *sp. nov.*	r
8 Ptilograptus plumosus *Hall*	rr
9 Loganograptus logani *Hall*	rr
10 Dichograptus octobrachiatus *Hall* (hexad type)	c
11 Didymograptus (Isograptus) gibberulus *Nich. var.* nanus, *var. nov.*	c
12 D. *sp. nov.*	rr
13 Leptograptus *sp. nov.*	r
14 Nemagraptus *sp. indet.*	c
15 Diplograptus dentatus *Brong.* (=D. pristiniformis *Hall*)	ccc
16 D. inutilis *Hall*	r

17	D. *sp. nov.*	
18	Retiograptus tentaculatus *Hall*	r
19	Glossograptus *sp. nov.*	c
20	Cryptograptus antennarius *Hall*	ccc
21	Trigonograptus ensiformis *Hall*	cc
22	Climacograptus *sp. nov.*	c
23	Lingula quebecensis *Billings*	r
24	Eunoa accola *Clarke*	r

Continuous with this bed of black shale is a layer of purplish gray shale with numerous light blue specks, probably originating from talcose mud pebbles. This layer contained:

1	Dichograptus *sp.* (branches)	c
2	Phyllograptus anna *Hall*	c
3	Diplograptus dentatus *Hall*	cc
4	D. *sp. nov.*	r

The aspect of the faunas of these two graptolite beds, which clearly belong to one zone, is totally different from that of the two preceding zones. Not only are all species new, with the exception of Loganograptus logani, Dichograptus octobrachiatus, Phyllograptus angustifolius, Ph. anna and Lingula quebecensis, and the prevailing genera different, but even the subclass of the Axonolipa, which hitherto alone held the field, has almost entirely been replaced by the family Diplograptidae of the Axonophora. The latter are represented by the genera Diplograptus, Climacograptus, Glossograptus, Cryptograptus, Trigonograptus, and Retiograptus.

A peculiar feature of this fauna is the sudden outburst of the Dendroidea with a Dendrograptus, four species, in numerous individuals, of Dictyonema (two of these of the rare subgenus Desmograptus), two Callograptus and a Ptilograptus. This subclass however, though reaching its acme already in Cambric beds, reappears, as is well known, with great force in the Niagaran and extends even into the Hamilton formation. As only the species of Callograptus and of Ptilograptus, one of each genus, are recorded from the Canadian exposure of this zone, the greater number of species and the profusion of speci-

mens of this long lived subclass may be of a merely local character.

On account of the radical changes in the composition of the fauna and of the large break in the section between the preceding and this zone, which, taking the average dip of the beds into account, may represent 300 feet of covered rock, it might be surmised that a number of zones must be missing between the two, and the succession of the zones is incomplete in this regard. Reference to the European succession of zones shows however that this is hardly the case, for in the Skiddaw beds, for instance, the same two zones have been found in direct succession. It is true, there may exist an intermediate, transitional zone, containing a more balanced mixture of the two faunas, such as has been found in Scania (*see* above, p. 569).

All the species of this fauna, described by Hall, were cited by him simply as coming from the Quebec group of Point Levis. In each description, however, the association is recorded in which the form was found, and from these records it becomes evident that the separate existence of this peculiar assemblage of species at Point Levis was well known to that illustrious observer. Lapworth (*loc. cit.*) found no material from this zone in the collections submitted to him, and therefore does not mention or locate this horizon in his series of graptolite zones.

Dr Gurley (*loc. cit.* p. 302) states that besides the fauna of the Main Point Levis zone he had before him a smaller collection of Point Levis shales, from a locality 1½ miles north of the east railway station at Levis, which has a strikingly different fauna; adding: "It was remarkable not so much for the species present (though the Diplograpsidae seem highly characteristic) as for those absent." His Ordovician table of graptolites (*loc. cit.*, p. 296 ff) proves that the third Deep kill fauna is identical with this second Point Levis fauna. Gurley calls the latter simply the "*Point Levis fauna*," and, together with two similar associations, from the Piñon range at Summit Nev., and from Arkansas, refers it to the upper Calciferous zones.

In *England* the zone with Diplograptus dentatus, Cryptograptus antennarius and Trigonograptus ensiformis is well developed in the *Ellergill*

beds, which form the lower part of the upper Skiddaw slates. Didymograptus bifidus rises there into this zone, while, on the other hand, Phyllograptus anna and Phyllograptus angustifolius are not reported by Miss Elles from these beds. Marr,[1] however, also cites the latter species. As Dr Gurley has also found Did. bifidus in the corresponding Point Levis zone and Phyllograptus anna in association with these Diplograptidae in Arkansas, it is apparent that these species rise in various regions into this zone.

The Ellergill beds are correlated by Lapworth, Marr and Elles with the *Llanvirn beds of Wales;* and by Miss Elles with *Tullberg's zones n), zone of Glossograptus* and *o), zone of Didymograptus geminus*, which form the basal part of the middle graptolite shales or of the *Dicellograptusskiffer* of Scania. These zones also contain the genera Diplograptus, Climacograptus, Glossograptus and Cryptograptus. The latter zone has again been subdivided into three subzones, the lowest of which (γ) still contains Didymograptus bifidus. This would suggest that the presence of the above cited species of the Phyllograptus anna zone in the zone with Diplograptus dentatus in America may eventually allow the recognition of subzones in the latter.

It will be noticed that in England this zone is placed above the Arenig formation, and that the corresponding zone in Scania is united with the middle graptolite shales, that, hence, important formational boundaries separate, in Europe, this and the preceding zone. This fact, in connection with the decided change in the character of the genera, which are those of the Middle and Upper Champlainic or Lower Siluric, may with our advancing knowledge of the graptolite facies of the Champlainic lead to the correlation of this zone with some part of the Chazy formation. This supposition seems to be well supported by a statement of Mr Walcott (*see* Gurley, *loc. cit.* p. 304), that "in Nevada Didymograptus bifidus occurs in strata certainly supra-Calciferous and probably of Chazy horizon."

[1] Geol. mag. 1894. 14th ser. 1: 127.

SUMMARY

The Deep kill section has furnished extensive collections of three different graptolite horizons which, termed after their most characteristic organisms, are:

c Zone with Diplograptus dentatus and Cryptograptus antennarius

b Zone with Didymograptus bifidus and Phyllograptus anna

a Zone with Tetragraptus

Two of these zones (*a* and *b*) are found in contiguous succession, the third is separated by a break in the exposure, but is certainly superjacent on the second zone *b*. In Great Britain and Scandinavia, all three zones have been observed in the same succession. In Canada, zone *a* is known from several regions, the most important being the Levis and St John regions. The typical fauna of zone *b* has become known from the beds near the St Anne river in Canada, and zone *c* is again present in the Levis beds. The succession of these zones has thus far not been reported as observable in any of these Canadian regions.

The stratigraphy of the Deep kill section demonstrates that the Main Point Levis beds or those of the Tetragraptus zone are the lowest of the series; that they are followed by the St Anne beds or those of the zone with Didymograptus bifidus etc., and *that the Point Levis beds, containing the zone with Diplograptus dentatus* etc., *overlie either directly the St Anne zone or are separated from it by only an intermediate transitional zone.*

As the Levis beds have been demonstrated to belong to the Beekmantown or Calciferous formation, the two lower of the zones certainly represent part of the graptolite facies of that formation, while the third zone may either belong to this or to the Chazy formation.

In using the results of a former investigation by the writer of the shales in the vicinity of Albany (N. Y. state mus. Bul. 42) the zones recorded in the first column of the following correlation table of the Champlainic or Lower Siluric graptolite shales can be claimed to have been discerned in this region.

Correlation table of the zones in the Champlainic (Lower Siluric) of the vicinity of Albany

Formation	Vicinity of Albany	Canada		Great Britain		Scandinavia (Tullberg)	Other regions
Lorraine	Zone with Dipl. foliaceus Coryn. curtus and Lorraine fossils (Waterford)	Lorraine beds	Caradoc	Zone with Dicellogr. anceps (Upper Hartfell shales) upper Caradoc of Shropshire with Dipl. foliaceus etc.	Middle Graptolite schists	Zone with Dipl. *sp. nov.*	Upper Maquoketa shales (Ohio and Miss. valley)
Utica	Zone with Dipl. quadrimucronatus, D. foliaceus, D. pusillus, Coryn. curtus, Triarthrus becki etc. (Rural cemetery etc.)	Utica beds with Dipl. quadrimucronatus (Quebec, etc) and Leptogr. flaccidus (Lake St John)		Zone with Dicellogr. complanatus (Upper Hartfell)		Zone with Dicellogr. complanatus	Dd 5 of Bohemia with Dipl. pristis
	Transitional zone with Climacogr. caudatus, Cryptogr. tricornis, Triarthrus becki etc. (Mechanicsville, Van Schaick island)			Zone with Pleurograptus linearis, D. quadrimucronatus, etc. (Lower Hartfell)		Zone with Dipl. quadrimucronatus	Lower Cincinnati, lower Maquoketa shales (Ohio valley)
Trenton	? Upper Dicellograptus zone (Lansingburg powerhouse)	Upper Dicell. zone (Quebec and Magog, Gurley) (= zone without Coenogr. gracilis Lapw.)		Zone with Dicranogr. clingani (Lower Hartfell)		Zones with Climacograptus vasae, Dicranogr. clingani etc.	Shale of Gembloux (Ardennes) with Climac. caudatus, Cl. styloideus, and sandstone of St Germain-sur-Ile with Dipl. foliaceus and D. angustifolius
	Zone with Dipl. amplexicaulis (Troy)			Zone with Climacogr. wilsoni (Lower Hartfell shales, Moffat etc.)			
Chazy	Lower Dicellogr. zone (Normanskill beds)	Lower Dicellogr. zone (Quebec, etc. Gurley) (= zone with Coenogr. gracilis Lapworth)	Llandeilo	Zone with Coenogr. gracilis (Lapworth) Lowest Moffat beds, Glenkiln shales		Zone with Coenogr. gracilis	Shale with Coenogr. gracilis of Victoria, Australia. Shales of Arkansas
	?	Beds of Mystic (Gurley)					? Graptolite shales of Kicking Horse pass, and Dease river, British Columbia (Gurley) ? shales of Nevada
Beekmantown	Zone with Dipl. dentatus and Cryptogr. antennarius (Deep kill)	Point Levis zone (Gurley)		Ellergill beds (Elles) (= Llanvirn, Elles)		Zones with Glossograptus and Didymogr. geminus	Grapolite shales of Arkansas and Nevada
	Zone with Didymogr. bifidus and Phyllogr. anna (Deep kill)	St Anne zone (Lapworth and Gurley)	Arenig	Upper Tetragraptus zone (Skiddaw slates, Elles) Upper Arenig beds of Scotland and Wales	Lower Graptolite schists	Zone with Phyllogr. typus and Didymogr. bifidus	Shales of Cabrières, France. Dd 1 of Bohemia with Didymogr. bifidus, Auriferous shales of Victoria, Australia
	Zone with Tetragraptus (Deep kill)	Main Point Levis zone (Gurley)		Lower Tetragr. and Dichogr. zones (Skiddaw slates, Elles). Middle Arenig graptolite beds of Scotland and Wales		Tetragraptus shales	Shales of Huy-Statte and Sart-Bernard (Ardennes) with Phyllogr. Dichogr. and Tetragr. Auriferous shales of Victoria, Australia

MODE OF GROWTH AND DEVELOPMENT OF GONIOGRAPTUS THUREAUI *McCoy*

BY RUDOLF RUEDEMANN

In 1889[1] Dr Ami announced the occurrence of Goniograptus thureaui in the Tetragraptus zone of Levis, Quebec. This remarkably pretty graptolite, the generic type and only species of the genus Goniograptus, was till then known only from the graptolite beds of the Bendigo gold field, Sandhurst, Victoria, Australia, whence it was described by McCoy.[2] It is there, as in the Levis and Deep kill beds, found associated with the species characteristic of the Tetragraptus zone. Dr Ami figured a remarkably large and perfect specimen and added the description of the central disk which extends in a peculiarly alate manner along the branches.

In the Deep kill section numerous hydrosomes of this species have been found, not only in the Tetragraptus zone, but also in the beds of the overlying zone with Didymograptus bifidus and Phyllograptus anna. The material from the former zone proved to be of special interest for the study of the ontogeny of the species, for it contained a complete series of finely preserved growth stages from the sicula onward to the mature colony. These stages allow the elucidation of some points in the ontogeny and morphology of the multiramose dichograptids which were hitherto not well understood; and they have therefore been made the subject of this notice.

A restricted number of characteristic stages has been figured. The outlines of the figures have, with one exception, been drawn with the camera lucida and reduced to their present size.

Sicula. The sicula itself is rather short and stout, as those of many other dichograptids; it can, therefore, when alone, be hardly distinguished from the siculae of several other species occurring in the same beds.

[1] Can. rec. sci. 1888–89. 3:422, 502.

[2] Ann. and mag. nat. hist. 1876. p. 128; Geol. Sur. Victoria. Prodr. pal. Victoria. Decade 5. 1877. p. 39.

Thecae. From this sicula buds at first, close to its distal end, one theca (1), which for a short distance grows in a distal direction along the sicula, then, turning abruptly under an approximately right angle, follows a horizontal or slightly downward direction (assuming the suspended position of the colony). (*See* fig. 1 and 3) The apparent angle of its divergence changes slightly, as is illustrated by fig. 2 and 3. From theca 1 is produced again by gemmation and close to its proximal end theca

Fig. 1 Goniograptus thureaui McCoy. var. postremus. Sicula and first two thecae (funicle). x3½

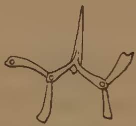


Fig. 2 *Idem.* Sicula (from antisicular side); and branches of first and second order. x3½

Fig. 3 *Idem.* Same, from sicular side. x3½

2, which, growing across the "antisicular" side of the sicula, diverges to the opposite side under exactly the same angle as theca 1. In older colonies the thick, straight, uninterrupted cross bar between the principal branches has been termed, in other multiramose dichograptids, the "funicle" by Hall and succeeding authors on graptolites. As the somewhat larger colonies usually settle on their broader surfaces, the sicula is brought into a vertical position, and hence often fails of observation in the fossilized state, as in fig. 4, where the central thickening indicates its location.

Each of these primary thecae produces in its turn (fig. 3), in a like position and manner as the sicula did, a new theca, which also, after a short adherence to the mother theca, turns aside at the same angle as does theca 1 and, like the latter, sends a new theca, corresponding to theca 2, to the opposite side. The bifurcation near the aperture of the sicula of the first two thecae is hence repeated at the aperture of each of the latter, and four secondary thecae result. These four thecae form the four "primary branches" of other authors. Each of these produces a new bifurcation (fig. 5 and 6) by the same process of twice repeated gemmation in two succeeding thecae, and the

assumption of opposite directions of the new branches. This would furnish eight "secondary branches". But a material change now takes place in the arrangement of the new thecae,

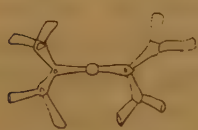


Fig. 4 *Idem.* Branches of third order have begun to form. Vertical view. x4

Fig. 5 *Idem.* Same growth stage. Sicular view. Shows mode of branching on left side. x3½

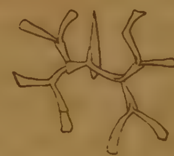


Fig. 6 *Idem.* A little more advanced stage. Antisicular view of sicula. x4

growing from these eight tertiary thecae. If we give the funicle a horizontal position in the drawing (fig. 7, 8), the four thecae (*a*) of these eight tertiary ones, which lie on the side of the vertical axis (A–B in fig. 8), produce thecae which do not diverge from their mother thecae, but retain the direction of the latter. This leads to a serial arrangement of the thecae and to the "denticulate branches" of other authors. The other four tertiary thecae (*b*) however, which lie subparallel to the funicle, produce a new

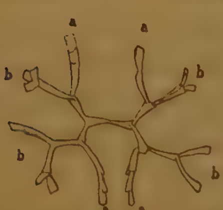


Fig. 7 *Idem.* Next growth stage. Differentiation of arrangement of thecae has commenced. *a* branches with serially arranged thecae; at *b* dichotomy continuing. x2½

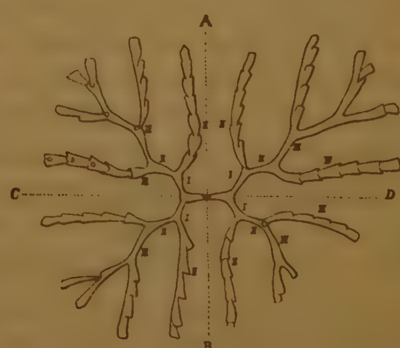


Fig. 8 *Idem.* A further advanced growth stage, which shows more distinctly the differentiation of the tertiary branches (III) and the composition of the four principal stems of thecae (see thecal apertures in upper left quarter). x2½.

bifurcation. They become thus component parts of the principal stems of the mature colonies.

Of the eight tertiary branches (marked III in fig. 8) resulting from these bifurcations, those subparallel to the funicle become denticulate, while the others bifurcate again.

This process of dichotomous branching and of the development of one of the resulting branches into a denticulate branch is repeated with absolute regularity. The result is the formation of four zigzag-shaped principal stems, lying in the diagonals of the rectangle, and of two alternating series of denticulate branches on each of these stems.

Fig. 10, 11 are reproductions of more advanced stages which differ from the younger ones principally in the length attained by the denticulate branches. Both specimens bear 24 such

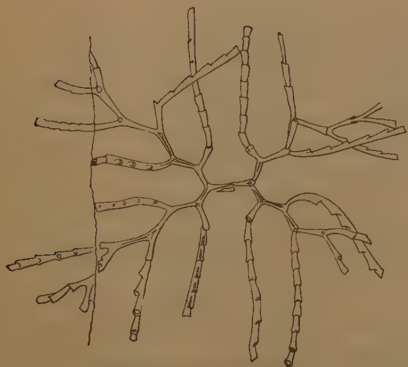


Fig. 9 *Idem.* Hydrosome with complete number of branches seen from thecal side. x2⅓

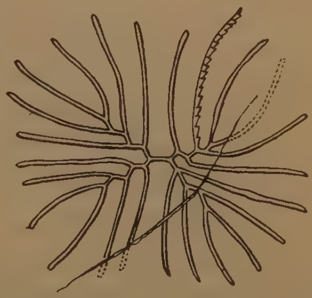


Fig. 10 *Idem.* Stage where dichotomous branching has ceased and all new thecae arrange themselves serially. Nat. size

branches, six on each stem and none of the many hydrosomes obtained at the Deep kill have a greater number of branches than six. As the ultimate branches of the stems are both denticulate, dichotomous branching appears to have ceased, and 24 seems to be the maximum number produced by these colonies. Dr Ami, however, figures a very large specimen, which, when complete, would have had about 80 branches. Specimens in the writer's hands attain about three fourths of the size of that referred to, without bearing more than 24 branches; also the smaller specimen figured by Dr Ami possesses a greater number of branches than colonies of like size in the Deep kill collection. These facts seem to indicate that the latter material contains a variety which, in the process of reduction of the number of branches, observable throughout the Dichograptidae, has advanced a decided step beyond the original G o n i o g r a p t u s t h u r e a u i,

and, like Dichograptus octobrachiatus and Tetragraptus, reached a stage with a fixed and more limited number of branches. This form would then stand at the

Fig. 11 *Idem.* Mature hydrosome. Shows the restricted number of branches (21), in this variety. Nat. size

end of the Goniograptidae, as far as the genus is known, and might be designated as Goniograptus thureaui var. postremus.

The important ontogenetic and morphogenic facts of which this series of growth stages permits a statement are:

1 *The "funicle" of Goniograptus consists of two thecae.* The equal length of the two parts of the funicle between the sicula and the first dichotomy and of the primary branches in the other multiramose dichograptids indicates that the funicle is in all these constructed of two thecae. With advancing growth of the colony, the two thecae of the funicle, like those of the principal stems, become greatly thickened and assume the form of cylindric stems, thus more or less losing indications of their former thecal nature (fig. 10 and 11). The statement, found from Hall's work onward in nearly all descriptions of the colonies of these multiramose dichograp-

tids, that the funicle is destitute of cellules, is, hence, correct only in so far as the denticulations or the apertural parts of the thecae are only distinct in young specimens and noticeable only at the points of bifurcation, but not along the funicle itself.

As to the group of Dichograptidae, represented by the genera Temnograptus, Schizograptus, Ctenograptus, Holograptus, Rouvilligraptus and Trochograptus Holm has noted the presence of a theca on each side of the sicula in the funicle of Trochograptus diffusus. Concerning the structure of the funicle in general that keen observer states:[1]

> On these grounds, and in consideration of the many-branched Dichograptidae being embedded in shale, and therefore showing the thecae of the central part of the polypary only in very exceptional favorable cases, and as these thecae are analogous to those in Didymograptus and other forms which are better exposed, I draw the conclusion that the funicle in many cases, if not always, was furnished with thecae.

This conclusion is fully verified as to Goniograptus and Coenograptus (fig. 13) by the writer's material. It becomes apparent from these observations that the funicle does not differ in structure from any other part of the stem; and probably in all Dichograptidae consisted of two thecae.

2 *The four principal stems of Goniograptus are composed of thecae, each internode between two bifurcations consisting of one theca.* For this reason all these internodes are of uniform length, and, because the angle of divergence of the budding thecae is constant throughout, the angles of bifurcation are all alike.

The next related genus, Clonograptus, which develops the greatest number of branches and is most irregular in the extent of its branching, has been considered, on account of these characters and its earlier appearance, the progenitor of a part of the multiramose dichograptids. It is a well known character of this genus that the internodes between the bifurcations not only grow to extreme length, but also

[1] Geol. mag. 1895. 4th ser. 2:484.

increase in length toward the distal parts of the hydrosome. That these very long stem-internodes, e. g. Cl. flexilis and Cl. rigidus, actually always consist of but one theca, as the increasing length of the stem thecae in fig. 12

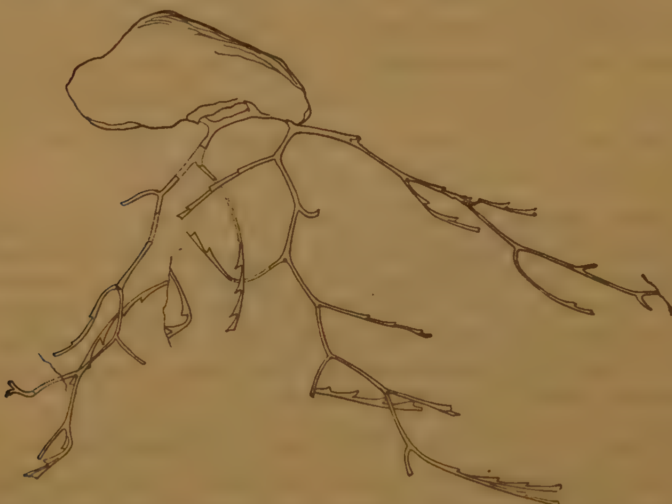


Fig. 12 Clonograptus (Goniograptus) *sp. nov.* Possesses long stem internodes, each consisting of but one theca. x2½

would suggest, the writer is not prepared to assert. As the stems of these forms, in conformity with Hall's fundamental views, have been currently considered as entirely indenticulate or free from thecae, they have not been investigated as to their structure, and conclusive data on the number of thecae in each internode are not to be obtained in the literature. Hall's position[1] was this:

Neither the central portion, nor any of its subdivisions, becomes celluliferous; and these parts are not termed stipes or branches, according to the views I have entertained. It is only beyond the last subdivisions of this part of the body, as in G. logani, that the celluliferous parts, or the true stipes, commence.

Miss Elles[2] states that she has observed thecae on stipes of every order in Clonograptus flexilis. Of special interest in this connection appear to be the description and illus-

[1] Can. org. rem. Decade 2. 1865. p. 20.

[2] Quar. jour. geol. soc. 1898. 54: 473.

tration of a Cambric species published by G. F. Matthew.[1] In this form the primary branches are short and evidently composed of one theca only, while all the branches of a higher order are longer and distinctly figured as consisting of several thecae.

If we compare this species with the lower Siluric species of Clonograptus or with the species of Dichograptus and Loganograptus, *e. g.* L. logani, where the primary and secondary branches are equally short, a tendency toward a concentration of the dichotomous branching in the central part of the colony becomes apparent.

The genotype of Dichograptus, D. octobrachiatus, and that of Loganograptus, L. logani, are found associated with Goniograptus in the Deep kill section, and occur in younger specimens, which indicate that these genera also conform to the composition of the internodes of one theca each.

The denticulate nature of the branches of the first and following order in Temnograptus was already known to Hall (Gr. milesi Hall) and has been recognized in its related genera (Holograptus, etc.).

Holm has described a coenograptid (Pterograptus elegans),[2] with a distinct thecal structure in the two principal stems, and the writer figures (fig. 13) a young specimen of Coenograptus gracilis itself, which distinctly shows the thecal structure of these stems.

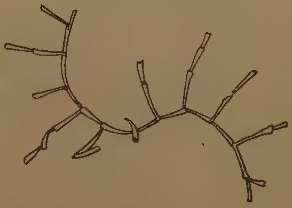


Fig. 13 Coenograptus gracilis Hall. Young hydrosome, which shows composition of funicle and principal stems of thecae. Normanskill shale of Mt Moreno. x4

It becomes therefore probable that all parts of the hydrosome of the Dichograptidae, including funicle and principal stems, consist of thecae; with the exception of the nema, which carries the sicula, and of the central disk.

3 *The growth stages of Goniograptus indicate that the bifurcations of the branches throughout the hydrosome take place in*

[1] N. Y. acad. sci. Trans. 1895. p. 295.

[2] Öfversigt af K. Vet. Ak. Förhandl. 1881. no. 4, p. 77.

the same manner as the formation of the funicle by the sicula, viz by the successive budding of two thecae, the second of which buds from the first, and both of which, assuming diverging directions, determine the direction of the ranches. This shows that the sicula, with its distal part, holds the position of a first theca, and that the funicle is genetically and morphologically not different from the branches of a higher order. From growth stages of Dichograptus and Loganograptus, obtained in the Deep kill collection, it can be deduced that the dichotomous branching of these genera conforms to the same law. The hydrosome of a new species of Bryograptus, common in the Tetragraptus beds, possesses the same mode of branching.

Holm[1] has demonstrated that in Didymograptus, Tetragraptus and Phyllograptus the same mode of branching persists.

As to the nature of the branching which has been termed "monopodial" or "lateral," and which is characterized by the continued growth of the original branch in the same direction after division, I have been unable as yet to obtain any conclusive facts. The genera which show this mode of branching most typically, are Schizograptus, Trochograptus, Holograptus and Rouvilligraptus. The fact, however, that both dichotomous and monopodial branching coexist in the hydrosomes of these genera, seems to indicate, that there can be no fundamental difference between them. Observations on Coenograptus (fig. 13) indicate the correctness of the suggestion of Wiman[2] that this mode of branching is produced by the greater strength which is attained by the mother theca before it produces the daughter theca, and which enables the former to retain its original direction while it compels the latter to a change of direction.

4 There must have existed physiologic and morphologic differences between the zooids of the biserially arranged

---

[1] Sveriges Geologiska Undersökn. Afhandl. och uppsatser. 1895. ser. C, no. 150.

[2] Geol. inst. Upsala. Bul. 1895. no. 4, v. 2, pt 2, p. 34.

thecae of the branches and those of the dichotomously dividing stems of Goniograptus which find their expression in the thecae. It may *a priori* be assumed that innate differences caused the zooids of the stems to assume widely diverging directions and those of the branches to grow in the direction of the mother theca. It is further evident that the essentially or solely nutritive zooids of the branches or stipes persisted in performing the function of nutrition while those of the stems (funicle, etc.) served this function only in the early stages of the colony, and later on, when they became thickened by chitinous deposits into cylindric stems (compare fig. 10, 11 and Hall's figures of Clonograptus rigidus), assumed as their principal or sole function the supporting of the branches. It is partly on account of this secondary adaptation to the latter function that the thecal nature of the stems has failed, till lately, to be recognized in the majority of the dichograptids.

This difference in function is, to some extent, also expressed in the morphologic differences between the stem thecae which we here call stolonal thecae,[1] and the branch thecae which may be termed brachial thecae. If one compares the extreme thecae of the branches of Goniograptus with those forming the stems (fig. 10; 14), one can not fail to notice that they differ. The latter, stolonal thecae, are more cylindric, very slightly widening toward the aperture and without any submucronate apertural processes; they, therefore, usually fail to appear as "denticulations." Their apertures are small, circular openings (fig. 3, 4, 5). The fully developed distant thecae in the branches widen more abruptly toward the aperture, have wider apertures and submucronate processes on the outer apertural margins. These differences can not be due to different degrees of compression in consequence of different thickness of periderm, or be caused solely by the superposition of the thecae on the branches.

[1] The first theca of each "denticulate" branch is to be considered as a stolonal theca on account of its assuming a direction different from that of the mother theca.

It must however be conceded that, as the initial thecae of the branches (fig. 14) are similar to the stolonal thecae, a phylogenetic element, to be discussed later, enters into this problem. But, even if to this latter element the principal weight in explaining the morphologic differences is given, the difference of direction assumed by the stolonal and brachial thecae, and the later thickening and functional change of the former, are sufficient to indicate an important difference in the zooids that once occupied the thecae.

5 *The stolonal thecae are more similar in shape and relative size to the sicula of the colony than the brachial thecae.* They widen in a similar degree and possess the same simple apertural margin.

In general, it may be said that all the thecae of a hydrosome conform to some extent to the sicula of that hydrosome, forms with long, slender sicula, having similar thecae and such with wider, shorter sicula, as numerous Tetragrapti and Didymograpti, having correspondingly shorter thecae; but at the same time, the sicula of each colony is still relatively longer and narrower than the average or extreme brachial theca.

A comparison of the form of the thecae of the younger dichograptid genera, as of Dichograptus, Tetragraptus and Didymograptus, with that of the older and presumably also phylogenetically preceding genera, Bryograptus and Clonograptus, shows that, in general, the older genera have the more tubular, simpler thecae with less protracted apertural margins. It is, hence, apparent that the stolonal thecae and the sicula represent the older type of thecal form.

6 The growth stages of the hydrosomes of Goniograptus thureaui prove further that also *within each branch only siculoid thecae are at first produced* (fig. 9, 10, 14). In fig. 14 the basal and distal parts of a branch of Goniograptus have been still further enlarged to show their differences more distinctly. The earlier thecae *a*, are tubular, lie subparallel to the axis of the branch (the angle between the axis and their outer margin is only 7°), overlap not more than one fourth of their length, have a straight aperture without marginal process,

while the later thecae *b*, widen more rapidly, lie more divergent from the axis of the branch (their outer margin forms an angle of 28° with the axis), overlap more than one half, have concave apertures and a slightly projecting outer apertural margin.

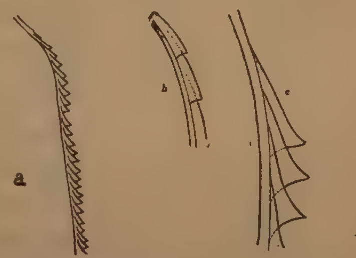


Fig. 14 Goniograptus thureaui var. postremus. *a* branch; *b* proximal thecae enlarged; *c* distal thecae enlarged.

7 It becomes apparent from these observations that the thecae of the colony of Goniograptus, from the sicula through the stolonal and early brachial thecae to the distal brachial thecae, form an ontogenetic series, which furnishes a clear and interesting example of "localized stages of development", the existence of which has been demonstrated and their character elucidated by R. T. Jackson.[1] In this remarkable publication it is stated (p. 90):

In organisms that grow by a serial repetition of parts, it is found that there is often an ontogenesis of such parts, which is more or less clearly parallel to the ontogenesis of the organism as a whole. In the ontogeny of such localized parts in a mature individual, we find stages in the development during the growth of the said part which repeat the characters seen in a similar part in the young individual. To state it briefly for the moment, such localized stages have been observed in the leaves of plants, in branches or suckers of plants, in the budding of some lower animals, as Hydra and Galaxea, in the plates of crinoids and Echini, in external ornamentation in mollusks, and in the septa of cephalopods.

From the examples cited those of Hydra and Galaxea are the most pertinent to our inquiry. In regard to them Prof. Jackson makes the following note (p. 141):

In animals which produce asexually by budding, as Hydrozoa and Actinozoa, it seems that the bud may be considered a localized stage. The bud has not the stages seen in early embryonic development from the egg, but repeats in general the later stages seen in such ontogeny. A bud is not a new individual in the full sense of the word, but is an outgrowth from an older individual by a special localized development.

[1] Bost. soc. nat. hist. Mem. 1899. v. 5, no. 4.

Fig. 15 Tetragraptus fruticosus Hall. Branch which shows progressive change of thecae. x2½

The application of the results of Jackson's investigations to the colony of Goniograptus is fruitful in more than one regard. It permits us to conclude that the branches of the hydrosome, like the leaves of a tree, indicate individually by their ontogeny the path along which they have been developed. The ontogeny of the branches demonstrates that the phylogenetically preceding forms possessed branches composed of more tubular thecae, with less overlap, looser arrangement, smaller deviation from the direction of the axis of the branch and straight, not mucronate apertures. Likewise, the whole colony was derived from colonies composed of such thecae, which are still retained in its oldest parts. The Cambric species of Bryograptus and Clonograptus exhibit well these types of thecal arrangement and structure. In the genera Tetragraptus, Didymograptus and Phyllograptus, where, within the Dichograptidae, the thecae have advanced farthest beyond their original form, the process of ontogenetic acceleration has also gone farthest in effacing all vestiges of the original thecal form, as *e. g.* in Didymograptus (Isograptus) gibberulus, where no sicoidal thecae are preserved. In others, however, as a study of Hall's excellent figures of the various species of Didymograptus will show, the gradual change from tubular to more gibbous, more closely arranged and more erect thecae can clearly be traced. The writer desires to illustrate these ontogenetic changes in the stages and arrangement of

the thecae within the branches by figuring a remarkably large and well developed specimen of Tetragraptus fruticosus (fig. 15) and a smaller new species of Tetragraptus, which eventually will be described as T. taraxacum (fig. 16). The latter species is characterized by remarkably slender proximal thecae and an abrupt change to erect, broad distal thecae.

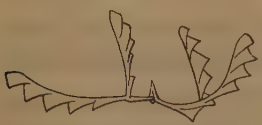


Fig. 16 Tetragraptus taraxacum *sp. nov.* Shows abrupt change from narrow to wide thecae. x3½

Fig. 17 Didymograptus (Leptograptus) *sp. nov.* Possesses short proximal and long distal thecae. x3½

That the direct opposite pattern to this compact structure represented by Tetragraptus and Isograptus, namely the extremely slender and graceful colonies of Leptograptus with their long filiform thecae, are likewise derived from a form having the Bryograptus type of thecal structure, is shown by the colony of a new species of Leptograptus from the Deep kill beds, which is represented in fig. 17. Here we have in contrast to the ontogenetic changes noted before, tubular proximal thecae, succeeded, as the branches lengthen, by extremely thin and long distal thecae which hardly deviate from the direction of the axis of the branch. The outgrowth of such extremely different, morphologically contrasted branches as those of Tetragraptus fruticosus, or T. taraxacum and of this Leptograptus from the identical type of proximal brachial thecae is certainly a strong argument for the propriety of viewing the changes within the branches as being of ontogenetic nature, and of corresponding phylogenetic importance.

Furthermore, the fact that the thecae within the same colony show a gradation from phylogenetically older to younger forms, and therefore, analogous to the organ of a growing individual, pass through ancestral stages, as, *e. g.*, do the septa of a cephalopod shell, demonstrates how closely the zooids of this colony were united into one organism, and that practically they were

more the organs of an individual than the component of a colony. Colonies are morphologically composite, but act physiologically as a unit. There are however all gradations from loose aggregates of individuals forming colonies to organisms in which, by division of labor, consequent supression of individuality and the presence of common organs, the colony also morphologically approaches closely to the character of a sole individual, e. g. the Siphonophora. Several important features of the graptolite colonies indicate that they also partook to a considerable degree of the character of a morphologic individual. This is specially suggested by the observation that several of the composite dichograptid colonies, as illustrated by the minute stages of Tetragraptus and Phyllograptus (fig. 18, 19), even in the earliest stages developed, by a rapid budding from the extremely small immature thecae (thecae are here meant to include or represent the zooids, which are not observable), the fundamental lines of the mature structure. This was possible because the buds are produced near the proximal ends of the mother thecae. Only afterward the thecae grew to mature size. This premature inauguration of the process of gemmation in individuals which have attained only a small fraction of their mature size, while reproduction in the animal kingdom takes place normally only in adult specimens, and the subsequent expansion of the whole stage, demonstrate that the early stages of these colonies did not grow by mere addition of buds, but also as entities. In the latter process, however, the thecae (zooids) appear entirely devoid of individuality and only as the subordinate parts of a whole growing body, which is then, certainly, to be regarded as a morphologic individual in so far as it grows as a unit or individual. The same uniform growth of the whole young colony took place also in Goniograptus, as the comparisons of the dimensions of

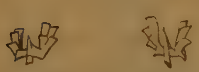


Fig. 18 Tetragraptus bigsbyi Hall. Minute growth stages. Sicular and antisicular views. x3½

Fig. 19 Phyllograptus ilicifolius Hall. Very young growth stage. x3

the youngest stages and of the resulting central parts of the later colonies will easily show.

It is significant that, as in the Siphonophora, the floating habit appears to have been principally instrumental in bringing about the development of other features suggestive of the morphologic individuality of the colony. Some of these are the presence of a common float or pneumatophor, observed in several groups, and the geometric arrangement of the branches, which becomes progressively more rigid, and which served to maintain the equilibrium and to give to the greatest number of zooids the most advantageous position.

If the graptolites so closely approached the morphologic value of an individual, it may be expected that, like an individual, the whole colony had its ontogeny and repassed ancestral stages. To these stages, as a glance at the regularly changing features of the growing colonies of Goniograptus will show, may be properly applied the terminology introduced by Hyatt for the ontogenetic stages of an individual.

The embryonic stage is clearly present in the initial part of the sicula, which, as Wiman has demonstrated, is differentiated from the distal part of the sicula by the nature of the periderm, which is thin, pellucid and possesses no growth lines. Holm[1] asserts his belief that this initial, more pointed end of the sicula "corresponds to the original chitinous covering of the free zooid germ or embryo." This initial part holds a position similar to the protoconch of the cephalopod shell. The nepionic or infantile stage is represented by the stages (fig. 1-6) in which the successive dichotomous divisions produce the stems. It begins with the formation of the apertural part of the sicula. The neanic or adolescent stage of the colony begins with the formation of the branches with serial arrangement of thecae and ends, in the Goniograptus material from the Deep kill, with the production of six such branches on each of the four stems. After this, in the ephebic or mature stage, the branches continue to grow out to full length. Distinctive

[1] Geol. mag. 1895. 2d ser. 32:435.

marks of theırontic or senile age have not been observed in these colonies.

There is no doubt that to these ontogenetic stages of the hydrosome of Goniograptus there are corresponding phylogenetic stages in the evolution of the genus, though the forms leading up to Goniograptus and to the preceding multiramose dichogratids are not known, the latter appearing unannounced in the Cambric.

Parallel series of growth stages of other multiramose dichograptids have been obtained in the Tetragraptus and Didymograptus bifidus beds of the Deep kill section. As they serve more to verify the observations made on Goniograptus thureaui than to bring out new facts, their description has been deemed unnecessary in this preliminary publication.

DESCRIPTION OF A

FOSSIL ALGA FROM THE CHEMUNG OF NEW YORK

WITH REMARKS ON THE GENUS

HALISERITES *Sternberg*

BY DAVID WHITE

Plates 3, 4

Though scores of fossil bodies from the Devonic and Siluric in both Europe and America have been described and published as seaweeds, few of them are now generally regarded as vegetable, the greater number having proved to be of animal or mechanical origin. Even among those survivors whose outlines and superficial aspect would seem at once to proclaim their unity with this great class of lower cryptogams, a very small number only are wholly free from the suspicion that they should be relegated to the sponges or the graptolites, or accounted for as the burrows of some other organisms. The admitted identity of the small remainder of Paleozoic thallophytes is in most cases based on the internal organization of such fragments as are so fossilized as to reveal their microscopic structure, rather than on their form and external characters.

The unsettled and somewhat chaotic status of the supposed Paleozoic algae can not be due to any lack of seaweeds during Devonic or Siluric time. Plant life of this class must have been and undoubtedly was in great abundance. The apparent rarity of unquestioned Paleozoic algae is due in the first place to the absence of hard parts in most seaweeds and the consequent failure, except in extremely rare instances[1], of preservation of any portion of the plant, specially of fragments showing the essential primary diagnostic details relating to anatomy or reproduction. Another partial explanation lies in the remarkable similarities in form and habit between many algae and certain contemporaneous low animal types, specially among the sponges

[1] Chiefly in the coralline types.

and sertularians, whose structure was so much better suited to preservation as to establish a presumptive hypothesis that the resemblant forms must embrace the animal characters of structure and would not have been preserved but for the presence of the latter. Still another reason is the close resemblance of the impression of partially macerated algoid fragments to the markings, trails and burrows of organisms moving on or in the sea bottom. A final reason, and one undoubtedly not the least in importance, is the very great scarcity of specimens sufficiently complete to show at once the form of the individual while at the same time affording some hint as to its internal structure. The material described below includes two of these extremely rare and important examples.

The principal specimens described in this paper are exposed on a slab from the Chemung strata at East Windsor, Broome co., and presented to the state museum by E. B. Hall of Wellsville N. Y. The slab is of greenish gray micaceous sandstone, and is rectangular, being about 73 cm long, 32 cm wide and 1 cm thick. The lower surface (with reference to its original deposition) reveals the ferruginated remains of two or more striking and beautifully displayed algoid fronds, one of which (pl. 3) appears to be nearly complete. The lower end of the slab also reveals portions of four segments that may either belong to a single frond or to the same tuft. Evidence of current action and rapid deposition of sand is seen both in the dragging of the large frond, and in the burial of the basal and lower portions of all the fronds before the more distant segments were covered by the sand. Accordingly we see the fragments in another of the fronds traversing the entire thickness of the slab, while the basis of the segments is not represented on this slab, having been contained in the underlying rock. All the segments lying at the plane of cleavage of this surface of the slab show effects of current dragging in a direction slightly oblique to the longer diameter of the slab. In the fine fragment shown on pl. 3, the deformation is more pronounced, while in both the peripheral and the thicker portions the lamina show

signs of maceration. The result is a greater confusion and intricacy of the outlines as well as a partial obliteration of the same in the upper parts.

The fossilized fronds originally contained considerable carbonaceous matter which is now largely, though not wholly, replaced by oxids of iron. The normal aspect and habit of the segments is rather better represented by the frond on pl. 4 (fig. 1) though even here dragging and the diagonal position across the bedding as well as maceration partially conceal the form of the segments. The latter features are shown to better advantage in the fragments of still another frond preserved on the opposite (upper) surface of the same slab.

In all the fragments the depth of the impression, the evidence of thickness at the margin, the position and outlines of the branchlets in the compressed form and the amount of carbonaceous matter show that the substance of the fronds was thick and fleshy. At the same time a close examination reveals the presence of a narrow median strand generally appearing in low relief but sometimes as depressed. The fleshy character, the median axis and the form of division or habit of the frond appear to distinguish the plant in hand both generically and specifically from all other described forms of supposed Paleozoic algae. In this instance, as in so many other Paleozoic types, including many genera of ferns, in which the organs of reproduction are unknown, the generic classification necessary for the proper recognition and paleontologic treatment of the fossils is wholly artificial.[1]

The plant from East Windsor may be described as follows:

THAMNOCLADUS *gen. nov.*

Fronds ramose, alternately dichotomous from the base upward, more or less elongated; lamina fleshy, linear, convex or subcylindric, tapering gradually, and traversed by a central axis or strand.

[1] The name proposed for this plant applies to the intricate copselike growth of the fronds and carefully avoids all implication of relationship to any particular family of living algae.

Thamnocladus clarkei *sp. nov.*

Pl. 3, fig. 1; pl. 4, fig. 1, 2

Fronds spreading, densely ramous, lax, pinnately and somewhat regularly dichotomous, intricate by reason of the repeated asymmetric divisions at intervals of 5–20mm; lamina relatively narrow, 1–7mm broad, thickest at the base, probably oval or subcylindric in section, narrowed slightly in each subdivision, the borders parallel, forking at a moderate or wide angle, and slightly recurved above each bifurcation, producing a graceful subflexuous form; central axis or strand slender, median or nearly so in the impressions, generally parallel to the borders, forking at a narrow angle a little below each dichotomy of the frond, tapering gradually upward, generally discernible throughout the greater portion of the flattened or macerated impressions, though often obscure in the basal portions or terete fragments.

One of the more important as well as conspicuous characters of Thamnocladus clarkei is its mode of division with a regularity and relative symmetry which, combined with the slightly divaricate attitude of the branchlets, results in a graceful flexuosity. The details of this habit which may be noted in the slender branches on the right on pl. 3 and pl. 4, fig. 1, are still more clearly seen in two isolated branches on a small slab[1] from Meshoppen Pa., shown on pl. 4, fig. 2. The more delicate segment in the latter beautifully illustrates the characteristic bifurcation and the gradual narrowing of the lamina with each successive subdivision. The width of the ultimate lobes is nearly the same, about 1mm, in all the examples. The Meshoppen specimens also indicate rapid sedimentation, since the lower portion of the fragment on the left completely traverses the slab, over 1cm thick, in an oblique direction. Its downward continuation was in lower strata. The central strand, while slightly clearer in the better preserved Meshoppen fragments is in precise agreement with the fronds from East Windsor.

The substance of the lamina in all the specimens has been reduced to a compressed carbonaceous residue which is mostly re-

[1] No. 25072 of the Lacoe collection, United States national museum.

placed by iron oxids. The rock is arenaceous and any expression of the structure is more or less obliterated by the coarse granular texture of the matrix and residue. In the lower portion of the segments this residue is obscurely marked in places, specially near the axis, by irregular longitudinal lines or striae; but neither these nor the rather indefinite strand seem to present a distinctly vascular aspect. The characters of the residue more strongly suggest the modified or pseudocompound structure of the more complicately organized algae, as in the stems of certain of the Phaeophyceae, rather than the vascular bundles or vessels of a fern.

Whether the fronds of Thamnocladus were borne on stipes is indeterminable from the material in hand, as is also the nature of the reproductive organs.

The distinction of Thamnocladus clarkei from other Paleozoic algoid forms from this country would seem a matter of little difficulty, as there are but few species which the plant in hand at all closely resembles. Buthotrephis gracilis Hall,[1] from the Trenton, is slender, flexuous, and slightly suggests the Meshoppen specimens, but the ramules are irregularly fasciculate, sometimes dilated upward, and generally as narrow near the base as at the top. B. subnodosa Hall[2] is also fasciculate. The aspect of fasciculation in Thamnocladus clarkei shown on pl. 3 and 4, is due to superposition, and is not a feature of the ramification. Even in these portions the central strand is generally visible in Thamnocladus. The fragment figured by Salter[3] as a " dichotomous rootlet " is somewhat suggestive of the American plant, though it is more rigid, narrow and distantly branching like some of the more slender examples referred to Psilophyton in America.

Thamnocladus is distinguished from Psilophyton by its lax, flexuous, dichotomous, bushy habit, the rounded or flattened

---

[1] Pal. N. Y. 1847. 1: 62, pl. 21, fig. 1.

[2] —— 1: 262, pl. 68, fig. 3. This species is generally indistinguishable by any described characters from the group known in Europe as Palaeochondrites.

[3] Quar. jour. geol. soc. 1858. v. 14, pl. 5, fig. 3.

lamina, and the absence of the fernlike pinnate ramification along a rhachis found in the latter genus. Psilophyton is vascular and more or less distinctly fernlike in habit. Thamnocladus is as distinctly algoid in form.

Among the living algae there are numerous species in various families which present a more or less close superficial resemblance to the plants described above. So far, however, as the external characters, to which our knowledge is at present confined, are concerned the greatest similarity appears to be with the Fucaceae, though our plant also suggests some of the Dictyotaceae, specially Haliseris delicatula. It may be compared also with the red alga Stenogramma interrupta Mont.

The material in hand appears to contain but little to indicate a probable relationship of the supposed seaweed to the orders of living algae. With respect to its habit and the aspect of its more or less macerated lamina the closest analogies would seem to be in the fucaceous Phaeophyceae, though the possibility of a relationship with the higher types of Chlorophyceae should be kept in mind. Both of these great orders, together with the red algae (Rhodophyceae) appear with little doubt to have been represented by early types in the Devonic or still older formations.

The fossils of the species here described as Thamnocladus clarkei have generally been recorded in American literature under the name Haliserites dechenianus Göpp., to which the Meshoppen specimens shown in pl. D and their associates were referred by Lesquereux. The identification with the latter species is based on the original figures and description given by Göppert[1] in his great work on the *Flora of the Transition series*. The specific identity of the plant described above with a portion of the Old World material identified by various authors as H. dechenianus is pos-

[1] Fossile Flora des Uebergangsgebirges. Nova Acta Acad. C. L.-C. Nat. Cur. Sup. v. 22, Breslau and Bonn 1852. p. 88, pl. 2, fig. 1-6. First named in N. Jahrb. f. Min. 1847. p. 686.

sible; but, even with the most liberal interpretation of Göppert's diagnosis, it is doubtful whether our plant is admissible to the same species as the latter's types, while, as will presently be seen, its generic characters are entirely distinct from those of the badly confused and questionable genus Haliserites.

The genus Haliserites was established in 1833 by Sternberg[1] for algae with flat, membranaceous, costate fronds, with capsular sporangia grouped beside the costae in the lamina of the frond. The original (solitary) species proposed is Haliserites reichii[2] from the Cenomanian greensand at Niederschöna in Saxony. This, the type of the genus, was referred by Bronn,[3] in 1838, to the ferns and accordingly described as Chiropteris reichii (Stb.) on account of its superficial characters, in agreement with that genus of ferns, and its association with a dicotyledonous land flora. Schimper[4] assigned the species to the recent genus Delesseria, and Fuchs regarded it as a true alga, comparable to Fucus vesicularis; but Rothpletz[5], after examining the original specimen concludes that its association with a land flora is against its algoid nature, and that, though no lateral nerves are discernible, it would perhaps be better to inscribe the plant as Phyllites reichii. Still later, Newberry in his work on the plants from the Amboy clays of New Jersey[6] describes a type which he regarded as no doubt generically identical with Sternberg's Haliserites reichii, but for which, since it can hardly have been an alga, he proposes the genus Fontainea. It was considered by Newberry as closely related

---

[1] Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt. v. 2, fasc. 5 and 6, p. 34.

[2] Op. cit. p. 34, pl. 24, fig. 7. "Frons stipitata, dichotime bipinnatim ramosa, fere pedata, ramis ramulisque costatis, fere dimidiatis, latere nempe exteriore deficiente, ramulis oblongis, obtusis, subfalcatis, costis stipiteque teretibus."

[3] Lethaea Geognostica. 2: 576, pl. 28, fig. 1.

[4] Traité Paléont. Vég. 1:178.

[5] Zeitschr. d. deutsch. geol. Gesell. 1896. 48: 904.

[6] U. S. geol. sur. Monogr. 1895. 26: 95.

to Fontaine's Sapindopsis variabilis; and Prof. Ward[1] appears inclined to concur in this opinion. The plant from the upper Devonic of America evidently is neither congeneric with Sternberg's type nor in conformity with his diagnosis.

Since the virtual abandonment of Sternberg's original type, Göppert's species, Haliserites dechenianus, which presents a far closer resemblance to the living Haliseris (Dictyopteris) has generally been made to serve as the type of the genus not only among Paleozoic forms, but even among Mesozoic species.

The name Haliserites dechenianus was first applied[2] to a plant from the Spirifer sandstone, lower Devonic, of Nassau. With his final description of the species Göppert[3] quotes Sternberg's generic diagnosis verbatim. The Nassau species he describes as having flat fronds, alternately dichotomously ramose, the branches and branchlets linear, of equal width, and sometimes circinnate, the costae being median. The form and proportions of Göppert's plant, specially in the fragments shown in pl. 2, figs. 3 and 4 of his *Flora* are so similar to the corresponding features of Thamnocladus clarkei as at first to make it seem that the plants are specifically identical. Against this, however, stand the apparently membranaceous texture, and the generally sharply prominent costa, which even appears to be partially torn free in one[4] of the Nassau types. With these differences in mind it becomes apparent that, as artificial genera are commonly understood, Göppert's plant can hardly be considered as congeneric with that from Meshoppen except we conclude it was wrongly described, and that it is not membranaceous, not circinnate, and probably not flat.

---

[1] U. S. geol. sur. Monogr. 1895. 26:96.

[2] N. Jahrb. f. Min. 1847. p. 686. Jahresb. d. Ver. f. Naturk. in Herzogth. Nassau. 1851. 7th Heft, 1st Abth. p. 141.

[3] Fossile Flora des Uebergangsgebirges. 1852. p. 88, pl. 2; *see also* Nova Acta Acad. C. L.-C. Nat. Cur. Sup. 1859. 27:442.

[4] Loc. cit. fig. 3.

The doubts which may arise as to the precise characters and nature of Haliserites dechenianus as described and illustrated by Göppert do not appear to be completely satisfied by reference to the interpretation put on it by other paleontologists. Most paleobotanists who have had to do with the species only in a casual way accept its algoid nature. Thus, Schimper[1] and Saporta[2] copy one or more of Göppert's figures while substantially reproducing his diagnosis under the same name. Among the authors who more carefully examined material there is difference of opinion. The Sandbergers, in their great work on the fossils of the Rhenish system in Nassau,[3] figure the species as a flat, membranaceous, more distantly bifurcating type with distinct slender median costae. The specimens, occurring at numerous localities supposed by the writers to be of Oriskany age, are described as having the lamina covered by a thin silky talcoid mineral, while the costa is converted to graphite. The form of the illustrated segments as well as the comments on the material appear to indicate an algoid type apparently congeneric with Göppert's, with which it was specifically identified. The specimen from the lower Devonic recently portrayed under Göppert's name by Potonié[4] appears to represent exactly the same form as that shown by the Sandbergers and seemingly belongs to the true algae, with which it is placed by the author.

In his *Fossil plants of the Devonian and Upper Silurian formations of Canada* Dawson[5] says: "there can be little doubt that the species Haliserites dechenianus Göpp., so abundant in the rocks of this age in Germany, is founded on badly preserved specimens of Psilophyton." Carruthers,[6] in agreement with Dawson, describes a number of apparently typical Psilophyton fragments from the Old Red sandstone of

[1] Traité Paléont. Vég. 1869. 1: 185, pl. 2, fig. 1.
[2] Monde d. Plantes. 1879. p. 172, fig. 2.
[3] Verst. d. Rhein. Schichtensyst. Nassau. 1856. p. 424, pl. 38, fig. 1.
[4] Lehrbuch d. Pflanzenpalaeont. 1899. p. 60, fig. 26.
[5] Can. geol. sur. 1871. p. 75.
[6] Seeman's jour. of botany. 1873. 2: 326.

Scotland as Psilophyton dechenianum, to which he refers Haliserites dechenianus Göpp., Lepidodendron nothum Salter, and Lycopodites milleri Salt. The synonymy of Psilophyton dechenianum (Göpp.) is much further extended by Kidston[1] so as to include, among others, Psilophyton robustius of Dawson, Lepidodendron gaspianum Dn. Hostinella hostinensis Stur, and the "plant" figured by Vanuxem[2] from the Hamilton beds near North New Berlin N. Y. Proceeding a step further, Malaise in agreement with other Belgian paleontologists inclines to the belief that Haliserites dechenianus represents the branches of Lepidodendron gaspianum Dn., a conclusion difficult to explain even on the assumption that Göppert's plant is a Psilophyton. Piedboeuf,[3] on the other hand, as the result of his studies of the fragments from the quarry in the Lenne shales (upper middle Devonic) in the vicinity of Gräfrath, on the lower Rhine, concludes that Haliserites dechenianus Göpp., Fucus nessigii, Dawson's Psilophyton, and Sphenopteris condrusorum Gilk. belong to a single fucaceous type which he calls Sargassum dechenianum. A fragment showing structure from the same quarry was studied by Solms-Laubach[4] who in 1894 described and illustrated it as Nematophyton dechenianum.

It is a long way from a taeniate, costate, membranaceous alga to a branch of Lepidodendron. So wide a variance in correlation can hardly be explained except by the supposition that some of the material submitted to the paleobotanists for examination had been wrongly identified or was misinterpreted by the writers themselves. Penhallow[5] in connection with the description of some Devonic plants from New York and Pennsyl-

---

[1] Cat. Palaeozoic Pl. Brit. mus. 1886. p. 232.

[2] Geol. N. Y. 3d dist. 1842. p. 161, fig. 40.

[3] Mitth. d. Ver. Naturw. v. Düsseldorf. 1887. Heft 1, p. 51.

[4] Jahrb. d. k. Preuss. geol. Landesanst. 1894 (1895). p. 88, 91, pl. 2, fig. 2-5.

[5] U. S. nat. mus. Proc. 1893. 16:108.

vania explains the discrepancy as due to confusion on the part of Göppert of Haliserites and Psilophyton at the beginning, representatives of both genera being included by him in the same species. Penhallow regards Haliserites as an alga which he defines as characterized by "Fronds plane, membranaceous, costate and dichotomous throughout; the more or less linear ramuli with simple terminations; sporangia in groups lateral to the midrib." As the true Haliserites dechenianus he describes and figures[1] a fragment[2] from Factoryville Pa. having the fronds regularly dichotomous at an angle of about 40°, the divisions linear, 3mm or more in width, equally and strongly costate throughout, with regularly wavy or ruffled margins.

From the foregoing it appears that the lower Devonic Haliserites of Göppert can not be regarded as congeneric with Sternberg's Cenomanian monotypic genus which is perhaps a dicotyledon; and that great uncertainty exists among paleobotanists as to the nature and characters of Haliserites dechenianus, it being regarded as a Psilophyton by some and as a taeniate, membranaceous alga by others. It is evident therefore that, whether Göppert's plant be one or the other, the name Haliserites can not, without violation of the common laws of nomenclature, be retained either for Psilophyton or for a genus of Paleozoic thallophytes.

For the flat, taeniate, costate, linear, regularly dichotomous, membranaceous algoid plant conforming to the genus Haliserites as defined by Penhallow[3] I would propose the name Taeniocrada.[4] The type species of the genus is Taeniocrada lesquereuxi, a specimen of which (no. 25164 of the Lacoe collection, United States national museum) was illustrated as Haliserites dechenianus in the 16th volume

[1] Loc. cit. pl. 10, fig. 6.

[2] 25164 of the Lacoe collection, United States national museum; from the Catskill at Factoryville Pa.

[3] Loc. cit. p. 112.

[4] The clause relating to the fructification should be omitted from the generic diagnosis, since the mode of reproduction of this and the allied species has not been observed.

of the United States national museum proceedings, pl. 10, fig. 6. This specimen, to which the above specific designation was applied in manuscript by the writer several years ago, is one of a suite from the Catskill beds at Factoryville Pa., now in the Lacoe collection. As will be seen by consulting the figure cited, the species is characterized by the wavy or ruffled lateral wing of the clearly membranaceous lamina, and the distinct costa, rounded in contrast but showing no signs of vascular structure. In form and aspect it is most nearly comparable to the living Dictyopteris delicatula Lam., though its lamina is wavy or ruffled at the borders in addition.

To the genus Taeniocrada would appear to belong also the specimens from the Devonic illustrated by Potonié[1] and the Sandbergers,[2] as perhaps may the Haliserites distans of Eichwald,[3] from the Carbonic of Russia, the H. lusaticus of Geinitz,[4] from the Permic of Saxony, and possibly the H. lineatus and H. chondriformis of Penhallow[5] from the upper Chemung beds at Lanesboro, Susquehanna co., Pa. Whether the specimens illustrated by Göppert as Haliserites dechenianus are congeneric with Taeniocrada, remains for the present a matter of doubt.

Of the plants from the Mesozoic described as Haliserites the H. contortuplicatus von der Marck[6] and H. gracilis Deb. & Ett.,[7] from the Senonian, are characterized as membranaceous and appear to owe their reference to this genus to their resemblance to the living Haliseris.[8] It is

[1] Lehrbuch d. Pflanzenpaleont. 1899. p. 60, fig. 26.

[2] Verst. d. Rhein. Schichtensyst. Nassau. 1856. p. 424, pl. 38, fig. 1.

[3] Lethaea rossica. 1860. 1: 49, pl. 1, fig. 2.

[4] Dyas. 1862. pt 2, p. 133, 336.

[5] U. S. nat. mus. Proc. 1893. 16: 110, pl. 11, fig. 8b and 9.

[6] Palaeontographica. 1863. 11: 81, pl. 13, fig. 13.

[7] Debey & Ettingshausen. Urweltliche Thallophyten. 1859. p. 61, pl. 1, fig. 1, 2.

[8] Other Mesozoic species described as Haliserites are: H. schlotheimi Debey (Entwurf. e. geogn. geogen. Darstell. d. Gegend v. Aachen. 1849. p. 31) and H. trifidus Debey (Verh. Naturh. Ver. pr. Rheinl. u. Westphäl. Jahrg. 5. 1848. p. 114) from the Senonian; H. tunguscanus Schmalhausen (Mém. Acad. imp. Sci. St Petersb. Ser. 7. 27: 59) from the Oolite; and H.? elongatus Fr. Braun (Münster's Beiträge. 1843. v. 6, no. 26, p. 26) from the older Mesozoic.

doubtful, however, whether, in the absence of knowledge of the frutification of the types, Cretacic and Devonic plants of this class should on account of a superficial resemblance be included within the same genus.[1]

The problem of the relationship of Göppert's types to Psilophyton or to the algae with membranaceous laminae seems to await thorough examination of the original specimens together with other material from the type locality or localities. It appears not improbable that Psilophyton will be found at the same stage and perhaps at the same localities. On the other hand it would not be strange if in the Psilophyton group, the doubts as to whose supposed structure were pointed out by Solms-Laubach[2], we should find transitional types between the algae and ferns and even other classes. And it should be borne in mind that such forms as Thamnocladus clarkei, while presenting the general aspect of many ordinary seaweeds, particularly among the fucaceous Phaeophyceae, and containing structural traces strongly suggestive of a somewhat highly organized axis, may eventually prove to be allied to Nematophycus (Prototaxites) or to some higher type.

The Devonic period offers a most fascinating as well as difficult field for paleobotanical investigations; and it has great need of ability and experience of the highest order to conscientiously and patiently work out the elements of its plant life, making the most of its generally scanty and obscure plant remains which must sooner or later throw the greatest light on the paleontologic origin of the ferns, equiseta, lycopods and gymnosperms.

[1] It would seem that in such instances the ancient types should receive some distinctive name, such perhaps as was given to the Paleozoic forms of Chondrites which Schimper designated (Zittel. Handb. Palaeont. 2:61) Palaeochondrites.

[2] Jahrb. d. k. Pr. geol. Landesanst. 1894 (1895). p. 74, 77.

A NEW GENUS OF PALEOZOIC BRACHIOPODS, EUNOA

WITH SOME

CONSIDERATIONS THEREFROM ON THE ORGANIC BODIES KNOWN AS

DISCINOCARIS, SPATHIOCARIS AND CARDIOCARIS

BY JOHN M. CLARKE

Plates 5–8

While exploiting a section of the "Hudson river shales" near the village of Melrose, Rensselaer co. N. Y., in the season of 1901, Dr. R. Ruedemann uncovered a remarkable succession of graptolite faunas representing the associations of those organisms found and heretofore described by Hall and others from the shales of the Quebec formation at Point Levis and Ste Anne in Canada. Of this interesting occurrence adding in a very important measure to our knowledge of the ancient faunas of New York, Dr Ruedemann has already given a preliminary account in this report, with a summary of the variation and vertical distribution of the graptolites. These graptolite-bearing horizons, three in number in the section exposed, are black shales interbedded with green grits and gray sands, and, while they have produced graptolites in great profusion and variety, other organisms prove to be very infrequent; some small oboloids like Paterula, two specimens of a great Lingula, the largest known from the Paleozoic, which approaches in general features L. quebecensis Billings from the Point Levis section, and several examples of a very large shell in which we recognize an interesting new type of brachiopod structure and purpose to describe under the generic name

EUNOA

Inarticulate, subcircular, disk-shaped shells of discinoid expression. Brachial valve slightly convex with apex situated between the center and posterior margin of the valve; pedicle valve flat with wide open triangular foramen having its apex at the center of the disk and with margins rapidly diverging to the periphery. Shell thin, chitinous, phosphatic; surface with raised concentric filiform lines and finer radial intralaminar striae.

Eunoa accola *sp. nov.*

Shells of large size, outline normally subcircular or transversely subelliptic; under compression appearing somewhat squared by abrupt curves at the side. Brachial valve with low radial lines diverging forward from the apex and seen best when the test is slightly exfoliated. These are evidently, in part at least, traces of muscular scars similar to such as are frequently displayed by species of the genus Orbiculoidea. The shell around the apex may have been continuous, but some specimens indicate an obscure and short peripheral notch or incurvature on the posterior edge.

In the pedicle valve the cleft is wide, and its apex nearly central. The edges of this cleft show convergent, thickened shell ridges, which lie just within the margins and unite at some distance in front of the apex, becoming thicker and more highly raised, thence continuing forward for a short distance as a single ridge, which soon fades out on the pallial surface. In the existence of these muscular fulcra we find again a parallel condition to that seen in many orbiculoids.

The shell substance is highly tenuous but seems to show a subdivision into two layers. Doubtless here, as in the cases of such brachiopods elsewhere observed in bituminous shales, the original lime content of the shell has been lost in fossilization; however, this lime content must have been slight and greatly subordinate to the phosphatic element.

These shells are all large, indeed the species is one of the largest of the inarticulate brachiopods. On bringing this genus into comparison with known allied genera, we observe that its differentials from those are as follows.

In Orbiculoidea, the wide open pedicle cleft is an embryonal and nepionic condition in all species where the ontogenic development has progressed normally. In Schizocrania it is a normal adult phase, but Trematis is a heavier lime-shelled genus with other differentials expressed in the submarginal apex of the brachial valve and in the ornament of the surface. Trematis likewise maintains the open foraminal fissure

but this is less primitive than in Schizocrania, its margins curving toward each other and approximating at the periphery. These two genera are early (lower Siluric) and phylonepionic expressions of Orbiculoidea. In Schizobolus (middle Devonic) the pedicle passage is a very short triangular notch, and the genus is a late survival of the primitive stage represented by E u n o a.

Trematobolus, Schizambon and Schizotreta are conditions in which the pedicle has not only become inclosed but also insheathed by a short tube.

The generic characters of the genus Eunoa are thus well defined, and no other shell carries so primitive an expression of the orbiculoid type, a highly phosphatic shell, simple, wide, triangular pedicle cleft and unmodified concentric surface ornament.

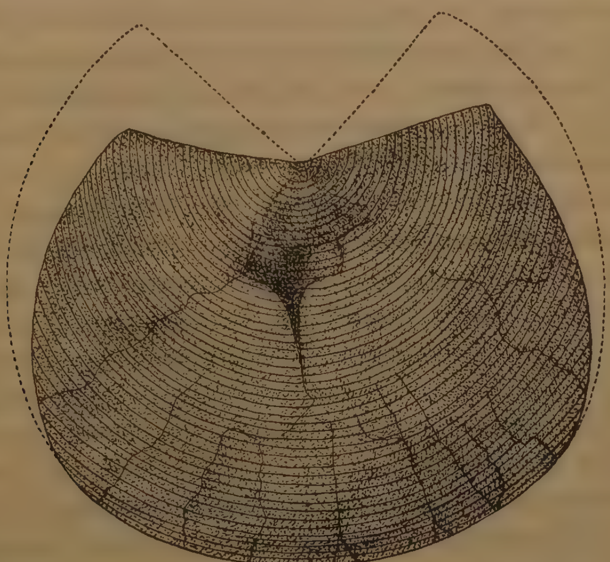
Horizon and locality. In graptolite shales of the age of the Beekmantown limestone, on Deep kill near Melrose N. Y.

Observations. The striking similarity of this organism to that described by Jones and Woodward from the Moffat shales of Dumfriesshire as D i s c i n o c a r i s g i g a n t e a leads to a few remarks which are naturally suggested by this resemblance.

Moffat series. The Moffat series of Dumfriesshire which has been described in great detail by Lapworth[1], is constituted of black bituminous shale bands with interbedded grits, the former carrying extensive graptolite faunules with such forms as Monograptus, Dicranograptus, Climacograptus, Dicellograptus, Pleurograptus, Leptograptus, Thamnograptus and many other genera which are present in the Deep kill section. Lapworth has found evidence for regarding the comparatively slight thickness of these beds as a sedimentary equivalent in the section where they occur, of the Siluric series from the middle of the Llandeilo up to the Wenlock, basing this deduction chiefly on the range and limitations of the graptolite faunas. There is herein a condition clearly parallel to that now determined for the Hudson river beds of eastern New York, whose graptolites have

[1] *See* specially Lapworth. The Moffat series. Quar. jour. geol. soc. 1878. 34:240–346.

fairly demonstrated their equivalence to sediments elsewhere extending from the middle Trenton upward to the top of the Lorraine shales. From these Moffat beds and in association with some of the graptolites, Prof. T. R. Jones and Dr H. Woodward have described a number of circular shields of chitinous substance, concentric markings and triangular cleft, as crustaceans under the name of Discinocaris. The type species of this group of putative phyllopods is D. browniana; and among them is the large shield to which we have referred, Discinocaris gigantea. Examination of the figure with restored outline given by these authors, which we reproduce here, shows



Discinocaris gigantea after Jones and Woodward

evidence of the convergent internal ridges showing through or impressed on the surface ornament and corresponding to these well marked muscular characters in Eunoa. This specimen is apparently the most nearly entire of any recorded; but the authors note that fragments of these bodies indicate a diameter of fully 7 inches. That Eunoa is a brachiopod of which we have both valves is beyond contest; and that Discinocaris gigantea, occurring in homotaxial rocks of similar character formed under like bathymetric conditions and with

similar organic associates, is also a Eunoa seems altogether certain.

This fact leads us to some further comment on the nature of other species of Discinocaris and similar bodies which have been described as phyllocarid crustacea, but whose nature has still to be satisfactorily demonstrated.

The organic bodies called Discinocaris, Spathiocaris, Cardiocaris, Pholadocaris, etc.

These organisms are all thin, chitinous, tenuous, oval, or cordate shields, bearing a deep triangular slit at one end extending back to the apex of the shell, about which the growth lines are concentric. These bodies abound at certain Devonic horizons, and some of allied form were early observed by F. Roemer and de Verneuil, who, familiar with the aptychi of the Ammonites in the mesozoic, designated them without attempt at closer investigation, as aptychi of the Goniatites.

Discinocaris was described by Woodward; and, though its forms, of which a number have been named, are in the features mentioned above not materially unlike the Devonic objects Spathiocaris and Cardiocaris, they are for the most part from horizons which long antedate the appearance of the goniatites. We have shown that one is evidently a brachiopod of large size, but this is one of the most recently described species referred to the genus.

The genus Spathiocaris was described by the writer. Following H. Woodward's determination of D. browniana etc. as crustaceans, Spathiocaris (Naples fauna) was also referred to this group of organisms.

Soon after describing the genus (S. emersoni), the writer referred similar bodies from the Devonic at Bicken, Westphalia, to Spathiocaris and Cardiocaris, regarding them as crustacea. Kayser at about the time of this publication, had discovered and described some of these bodies from Bicken as occurring in, though not well fitting, the body chamber of the goniatite, Manticoceras intumescens. Similar occurrence was noted by Woodward in a goniatite from

Büdesheim. Dames vehemently contended that none of these bodies was crustacean, that all their characters pointed to their function as operculums of goniatites, so far as goniatites existed at this time, and, as for the rest, their nature was unknown. Woodward, subsequently reviewing all the evidence, admitted that some of the bodies were of goniatite nature, but concluded from analogy with such shields as Peltocaris (lower Siluric), in which the triangular cleft was indubitably covered with a rostral plate, that the others were rationally ascribable to the crustacea.

The latest observations on these bodies are those of Holzapfel supplementary to his description of the Goniatites of the *Domanik schiefer*. It was from these shales that de Verneuil described the first known of these bodies as aptychus of a goniatite. Holzapfel, in rehearsing all the evidence in more detail than is given in the foregoing and without attempting to enter upon an analysis of possible crustacean structure, concludes that at any rate Spathiocaris and Cardiocaris were not aptychi or ammonoid operculums. That they may not have had some other function in the ammonoid body, he is not disposed to deny. From so high an authority on the structure of the goniatites this opinion carries much weight; and Holzapfel reiterates the statement by de Verneuil that these bodies occurring in the black layers of the Domanik schiefer are not immediately associated with goniatite shells.

The writer has repeatedly drawn attention to the same feature of the occurrence of these bodies in the Naples and Genesee beds of New York, where, after 25 years of search and the acquisition of hundreds of spathiocarids, in no instance has any specimen been observed in association close enough to suggest, of itself, any relation to the ammonoids. We are now speaking of the singly cleft shields, such as have been in two recorded instances found within the goniatite chambers in the limestones of Germany, as above referred to.

Here is evidence of affinity which points both ways. To prove these bodies opercular shields or covers for any other parts of

the cephalopod body, the following obstacles must first be cleared away: 1) They are usually completely dissociated from the cephalopod shells. 2) Some forms of Discinocaris and Peltocaris of the early Siluric are virtually indistinguishable save for outline and size from Spathiocaris and Cardiocaris of the Devonic. The former appeared at a time long antecedent to the ammonoids. We know that one of those early species was brachiopodous, the others are not goniatitine; the later forms can hardly match our conception of brachiopod structure. Objects of so similar a character would *a priori* be of similar nature, an argument which, if carried to a logical conclusion, would wreck the inferred goniatitine character of the Devonic genera. In meeting these obstacles it is to be borne in mind that no single specimen of any of the genera Discinocaris, Pholadocaris, Spathiocaris, Cardiocaris has been proved crustacean. The segments and spines referred to these may or may not have any relation to the shields themselves.

There is a series of these shields which is unlike those specially mentioned above, in having a triangular cleft at both extremities, that behind not reaching to the apex or growth center of the surface, but often broader than the anterior cleft. These are wholly Devonic objects and have been termed by the writer Dipterocaris. American specimens have been found not so much in the bituminous layers of the upper Devonic as in the flags and sands, and certain specimens have clearly indicated that in uncompressed condition the contour was distinctly sloping from the bridge between the two lateral wings of the shield. Among these specimens there is no room for any suspicion that they have brachiopodous affinities. Regarded as crustacea, that is Phyllocarida, at the time of the description of the genus, the crustacean similarities are indeed more strongly marked than in the Spathiocaris class of shields, a feature specially brought out on comparison between such a Dipterocaris and the carapace of a phyllocarid like Rhinocaris or Mesothyra; but on the other hand the general form, structure and surface characters of all these

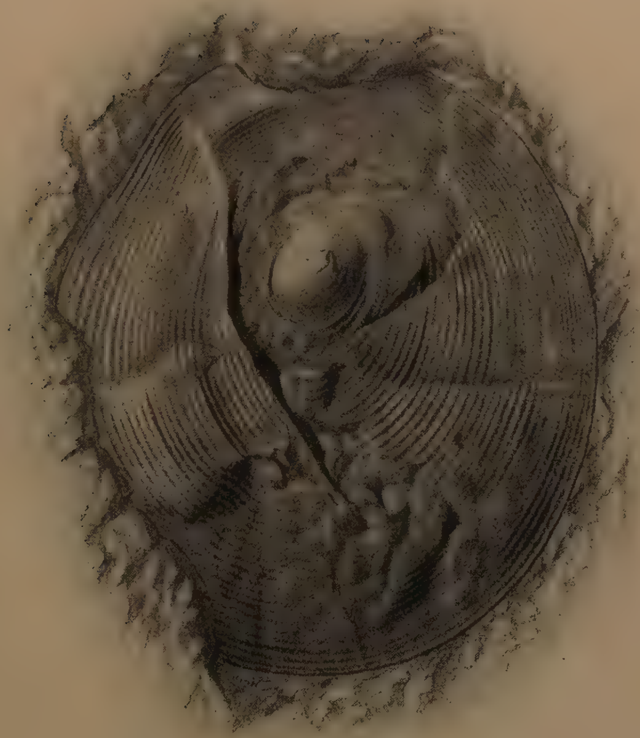
bodies (specially Devonic bodies) are so much alike that whatever course of argument applies to one seems of necessity to apply to the rest, the more as they are concurrent in the rock strata. Yet in these bipartite shields we find a closer analogy, if any, to the ammonoid aptychi of the Mesozoic, so far as the division of the shield is concerned. It has been argued by various writers that the tenuous chitinous substance of these bodies is purely a result of preservation. Calcareous substance is frequently destroyed in bituminous shales; hence the calcareous layers of these bodies may have been thus removed, leaving only the organic film. Specimens from the sandstones are however equally devoid of trace of calcareous layer. It has furthermore been contended that these presumable aptychi, on the decomposition of the animal's body, have been floated by the waves unable to transport the heavy shells, and have hence been accumulated by themselves in other sediments than the latter; a plausible contention could we but find some more satisfactory ground in the structure of the "aptychi" for ascribing this cephalopod function to them.

In the *Paleontology of New York*, v. 7, we figured the sole instance known from the rocks of this state of the concurrence of any of these bipartite bodies with a goniatite. Here is a specimen from the soft Naples shales, presenting a body whorl of Manticoceras pattersoni, the diameter of whose shell originally was not less than 3 inches. On and within its body chamber lies a Dipterocaris or at least an object having the doubly cleft outline of the species so denominated. This little body has a length of about 5 mm. This concurrence may, of course, be quite as casual as the usual dissociation of these bodies. If, however, this be taken as an indication of relationship between the ammonoid and the Dipterocaris, it is not the relation of aptychus or operculum. However, in view of all the present evidence, we can not divest ourselves of the belief that there is nevertheless some organic connection between these Devonic bodies and the cephalopods; for, while we lack any further confirmation of the latter than that above

given, we have been altogether unable to acquire positive indication of crustacean structure in any of them.

In this connection I take opportunity of referring to a body from the upper Devonic, which has the aspect common to all these genera, the tenuous shield concentrically striated, but a size which greatly surpasses them. On an accompanying plate is figured such a specimen taken from the upper layers of the Portage group in the Tannery gully at Naples, a horizon which has produced a number of singular objects, Paropsonema cryptophya, some undescribed gephyrean worms and other unrecorded occurrences. This object is one half of a singly cleft shield resembling a circular Spathiocaris or Cardiocaris.

In the collections of the state museum there has been for many years a plaster cast, and among the archives a pencil sketch, of a large discinoid body taken from the Ithaca beds of the upper Devonic (Portage stage) at Truxton, Cortland co., both cast and drawing sent to the late Prof. Hall by the late Rev. H. A. Riley of Montrose Pa., a well known collector and student of fossil organisms. It will be observed from the accompanying figure of this body that the furrow which crosses the surface of the body is accidental, not natural, as it not only divides the body into unequal parts but is crossed by the concentric rings of growth. The body was originally depressed conical, as shown by the irregular wrinkling of the surface under compression, the beak being well forward of the center and the concentric lines conspicuous but not relatively so to the size. The dimensions of this object are specially noteworthy; fore and aft it was not less than 5 inches long and transversely through the center nearly 6 inches. The Naples shield has just about the same dimensions. Either of these bodies by itself fails to explain its true nature; taken together, I am disposed to believe that all the evidence indicates that the one is probably the correlate of the other, one a pedicle valve, the other a brachial valve of a great inarticulate brachiopod like Eunoa. We should probably go astray in identifying this great shield generically with Eunoa from the Melrose graptolite beds; and in view of



Orbiculoidea magnifica

Upper or brachial valve

Since this article was put in pages the specimen here figured has been obtained from the Tannery gully at Naples, the same locality and horizon which furnished the folded pedicle valve shown on plate 7. The presumption made in the paper that that body appertained to a discinoid brachiopod is thus fully justified by this recent acquisition.

the fact that there is no structural character which distinguishes the shell from the genus Orbiculoidea, we propose to term it provisionally O. magnifica, in the hope that this brief notice of the object may draw the attention of collectors to it as one of which we seek further information.

STRATIGRAPHIC VALUE OF THE PORTAGE SANDSTONES

BY D. D. LUTHER *

James Hall, in his *Report on the survey of the fourth geological district of New York*, 1843, p. 24, thus described, under the caption "Portage or Nunda group", the strata succeeding the Genesee shales in the valley of the Genesee river:

This group presents an extensive development of slate, shales and flagstones, and finally, some thick bedded sandstones toward the upper part. Like all the other mechanical deposits of the system, as they appear in New York, it is extremely variable in character at different and distant points. . . From its superior development along the banks of the Genesee river in the district formerly included in the town of Nunda, now Portage, it has received that name to distinguish it from the higher rocks, which possess some differences in lithological characters, but a more striking dissimilarity in organic remains.

On p. 226, he says: "On the Genesee river this group admits of the several subdivisions shown in woodcut 97, which are, in upward order 1) Cashaqua shale, 2) Gardeau shale and flagstones, 3) Portage sandstones."

The footnote accompanying the woodcut says: "As we go east from this point, however, there is a constant increase in arenaceous matter, and in a westerly direction an increase of mud or shale."

The strata that compose the Portage group as thus defined are exposed almost continuously in the sides of the deep canyon of the Genesee river from near its opening into the wide valley near Mt Morris, to the top of the cliffs on the south side of the high railroad bridge at Portageville, a distance of 15 miles in a direct line, and about 20 along the tortuous river channel. The difference in elevation between these points is 680 feet, and the dip adds 381 feet to the rock section; total thickness 1061 feet.

The Cashaqua shale was described as a "soft argillaceous rock of a green color . . . it contains flattened concretions of impure limestone and sometimes of sandstone, but of these it contains no continuous layers." It is favorably exposed 6 miles east of the Genesee gorge on Cashaqua creek and can be easily traced westward to Lake Erie and eastward to Seneca lake; throughout the entire distance it is found to overlie a bed of black shale in which fossils are exceedingly rare. In the river section this bed is about 35 feet thick. This has been termed the lower black band and is continuous and well defined from the Naples valley on the west to Lake Erie, increasing slowly in thickness.

Next below, and overlying typical upper Genesee shale, are 4 to 6 feet of lighter colored shales and a few thin flags, the whole bearing a much closer clastic and paleontologic resemblance to the Cashaqua shales than to the dark gray shales bearing Lunulicardium fragile abundantly, on which they rest.

Overlying the Cashaqua beds occurs another thick mass of densely black slaty shale, known as the second black band. It is of the same character as, and coextensive with the lower mass and like it increases in thickness toward the west, while the Cashaqua shales decrease in that direction. These two black bands are bench marks in the stratigraphy of the Portage sections as their character is maintained and they are easily recognized for more than one hundred miles east and west of the typical section, while the other beds are variable in character and not to be distinguished without much care and study.

The second of Hall's divisions, the "Gardeau shale and flagstones" was described (p. 227) as "a great development of green and black shales with thin layers of sandstone." It includes the second black band which is its basal stratum. The upper limit was not definitely given, as the only change noted in the character of the sedimentation is the increase of arenaceous matter toward the top. "Towards the upper part the courses

of sandstone become too thick for flagstones and the shale is in thicker masses than below" (Hall, p. 228).

About two thirds of the strata comprised within the typical Portage section are represented by this middle division, the base of which is at the river level at the lower end of Smoky hollow, about 5 miles above the mouth of the gorge at Mt Morris, 613′ A.T. The upper limit, which for the purposes of this paper is assumed to be about 27 feet above the crest of the upper fall at Portage (1082′ A.T.) is 506 feet higher than the base, and the southward dip adds 208 feet, making a total of 714 feet for the thickness of the Gardeau division.

With regard to the Portage sandstones, Dr Hall said on p. 228 "The thick bedded sandstones at Portage form the terminal rocks of the group. . . The upper part consists of thick bedded sandstones with little shale, while below the sandy layers become thinner, with more frequent alternations of shale."

There are 182 feet of strata embraced in the section between the assumed base 27 feet above the upper fall and the top of the cliff south of the bridge and on the east side of the river. A layer of hard blue shale, 2 feet thick, occurs 12 feet above this assumed base, and another of similar character is found 52 feet higher; very thin shaly partings also separate some of the harder layers, but with these slight exceptions the formation consists of layers of light bluish gray, medium fine grained sandstone from 2 to 10 feet thick. The character of the rock is remarkably uniform, varying but slightly in the degree of hardness, some layers showing a tendency to be schistose or flaggy; occasional concretions occur.

"The Portage sandstone is succeeded by olive shaly sandstone and shale and this by black micaceous slaty shale with septaria; to this follow shales and coarse sandstones with fossils of the Chemung group" (Hall, p. 248). These beds are not exposed along the river but the lower portion may be seen in the ravine of Wolf creek below Hopkins's mill at Castile, and the upper part in the ravine of West Coy creek at Wiscoy, and in

several ravines on the east side of the upper Genesee valley opposite Fillmore.

These beds which cap the Portage sandstones and still retain the characteristic species of the rocks below have been termed by Clarke the Wiscoy beds. They are composed mainly of soft shale, bluish and argillaceous, or olive and sandy, with occasionally thin black layers, a few flags or thin sandstones and calcareous concretions.

They are terminated by a band of flags and thin sandstones that appear in the north wall of the ravine above the falls at Wiscoy, and in the sides and bottom of the river channel a mile south of Fillmore where they form " Long Beards riffs."

These latter sandstones are about 150 feet above the Portage sandstones and are the lowest " coarse sandstones with fossils of the Chemung group " that have been found in the immediate vicinity of the Genesee river. They are succeeded by nearly 300 feet of shales and flags and these are overlain by the heavy Rushford sandstones, exposed in the hills west of Caneadea. Chemung fossils are common through this mass of shales and sandstones.

The Portage sandstones in the Genesee river are therefore separated from any lithologically similar formation for 450 feet above and none of like character of sufficient thickness to cause confusion in correlation, occurs below.

Recapitulating, the subdivisions of the rocks of the Portage group in this section, that by their individual characteristics, their homogeneity and their thickness are so well defined that they may with safety be used in correlation with other local sections, are: the lower black band, 35 feet, the Cashaqua shale, 130 feet, the second black band, 52 feet, the Portage sandstones, 182 feet.

Besides these, there occurs in the lower part of the Gardeau beds, interstratified between beds of shale, a band of flags and thin sandstones aggregating about 25 feet in thickness, that becomes a more distinct feature in the stratigraphy toward the east, and will be referred to again in this paper.

The character of the fossils in this group of formations has been fully discussed by Clarke. The fauna of the Portage series as a whole is highly distinctive and not to be confused with that preceding or with the Chemung fauna which follows. The latter is specially characterized by prevailing brachiopod types, a group almost wholly wanting in the Portage, and *per contra* the peculiar lamellibranchs and cephalopods of the Portage are not carried over into the Chemung fauna save as one species or another may have survived the general invasion of the Chemung fauna from the east.

In the town of Naples, about 30 miles east of the Genesee river the upper beds of the Genesee shale, all of the Portage divisions and several hundred feet of lower Chemung strata, in the aggregate not less than 1500 feet, are abundantly exposed in the numerous ravines and rock escarpments about the south end of the Naples valley.

In the strata above the Genesee shale the proportion of sandy sediment, in the shape of flags and thin sandstones is noticeably greater than in the Genesee river section, and the thickness of the subdivisions is not the same, still the differences in lithologic character are so small, that no difficulty is experienced in distinguishing the several subdivisions as previously described.

The upper beds of the Genesee, succeeded by the band of lighter colored shales and flags, and next above, the lower black band are exposed along the road leading westward on the Naples-Bristol town line near Woodville and near the mouth of the Snyder gully, $\frac{1}{8}$ mile south.

The top of the Genesee shale in the road west of Woodville is 751′ A.T. This point as indicated on the Naples sheet of the topographic map is on the line of 42° 40′ which crosses the Genesee river 5 miles south of the mouth of the gorge at Mt Morris and almost exactly at the place where the top of the Cashaqua shale dips below the river level, which is here 602′ A.T. The top of the Genesee shale at Woodville is therefore the difference in levels, 149 feet, plus the thickness of the

Cashaqua shale on the river section, 165 feet, or 314 feet higher than it is on the Genesee river, thus showing an average eastward elevation or pitch of 10½ feet a mile.

The Cashaqua shale is abundantly exposed in a large number of ravines that score the hillsides between Canandaigua lake and the village of Naples. The beds are quite sandy, flags being common and a few layers of sandstone reach a foot in thickness. The upper part is more argillaceous and calcareous than the lower, and it is also more fossiliferous, the characteristic fossils of the group being quite common in the softer shales.

The second black band, less than half as thick as in the Genesee river section, but well defined and easily distinguished is exposed in the same ravines, and also in the rock cut on Rhine street, and at the foot of Hatch hill, opposite the village of Naples, where it dips under the water of Naples creek at about 775′ A.T.

Abundantly exposed at the foot of Hatch hill, and in the upper parts of the ravines at the north, but much better in the Tannery gully, 1 mile south, and the Grimes gully ½ mile west of the village, there are about 300 feet of shale and flags that correspond very closely, both in structure and fossils, to the Lower Gardeau beds as they appear in the escarpments between Smoky hollow and the top of the upper Portage fall. The shales are black, bluish or olive, in all varieties, and the sandstones light bluish gray with different degrees of hardness. At some horizons the proportion of arenaceous matter is very small, while at others it is equal to the argillaceous.

At the top of these beds, and about 600 feet above the Genesee shale a series of sandstones, varying in thickness from an inch to 8 feet, and separated from each other by thin shaly partings, and aggregating about 50 feet thick, produce the third falls in the Grimes gully, the High falls in the Tannery gully, and prominent escarpments on the sides of Hatch hill and West hill. They are known as the Grimes sandstones. Their most southern exposure is on Olney brook at the waterworks reservoir 1½ miles south of Naples, at the elevation of 975′ to 1025′

A.T. Though the individual members of the series frequently change in character and sometimes pinch out entirely within short distances the formation as a whole is continuous for many miles toward the east and west. As the subjacent and the overlying beds are composed almost entirely of soft shale the sandstones usually produce falls where a hillside stream crosses this horizon and make more or less well defined escarpments on the sides of the valleys.

The proportion of sandy sediment in the Grimes sandstones as in the flag and shale beds below, is much less in the river section, but the formation maintains its character sufficiently to be noticeable as a distinct band of flags and thin sandstones in the cliffs on the east side of the river at St Helena, and also 1 mile southwest, where it comes down to the river level near the mouth of Wolf creek, almost exactly west of the exposure at the reservoir in Naples, at the elevation of 675′ to 700′ A. T.

Up to the base of the Grimes sandstones the similarity in both lithologic and paleontologic aspects of the two sections makes correlation simple but at this horizon, in the Naples section, the Portage fauna suddenly and finally disappears, while in the Genesee section it holds its place to the exclusion of all brachiopods to a horizon that, stratigraphically, is 700′ to 800′ higher.

The last appearance of the normal Portage fauna in the Naples section is in some thin layers of soft shale between flags, in the face of the precipice at the third falls in Grimes gully, and this fauna is found also in similar shales at the same horizon in Tannery gully at the High falls.

24 feet higher and 9 feet below the crest of the falls a 4 inch layer of soft sandstone contains Liorhynchus quadricostatus, Atrypa reticularis, Productella speciosa, Ambocoelia umbonata var. gregaria, Leptostrophia mucronata and Orbiculoidea sp., an assemblage regarded by Clarke as altogether foreign to the Portage or Naples fauna. These fossils are found along the line of outcrop of this layer for four or five rods on both

sides of the cascade but nowhere else in the valley at this horizon. This layer is 600 feet above the Genesee shale.

The Grimes sandstones come in in full force 4 feet above this layer and are well exposed in the floor and sides of the canyon above the falls, but appear to be barren of fossils. They are exposed in a similar manner at the top of the High falls in the Tannery gully. No fossils are found here at the base of the sandstones but near the middle of the beds an extensive lenticular layer a foot thick is composed principally of crinoidal segments and comminuted brachiopods and shows a few specimens of Liorhynchus, Atrypa, Productella, Ambocoelia umbonata and a small Chonetes in a recognizable condition.

This calcareous lentil extends 60 to 80 rods toward the north and outcrops slightly in the fields on the north side of the road leading up Hatch hill. A few feet higher occur species of the dictyosponge Hydnoceras with Paropsonema cryptophya, a large Orbiculoidea and other problematic organisms not elsewhere seen. A Leptodesma of notable size and not seen in the beds below occurs in the lower part of the Grimes sandstones in the small Smith ravine south of the Tannery gully and also in a field outcrop in Nellis's pasture 1½ miles northeast of the village. The same fossil appears on the surface of a thin sandstone about 50 feet above the Grimes sandstones in the Lincoln gully on the opposite side of the valley. Sponges, crinoids and a few brachiopods have been found in these sandstones at several other outcrops in the valley.

The Grimes sandstones are succeeded by shale, flags and thin sandstones in varying proportions for about 600 feet to the base of the High Point sandstones. Very few of the harder layers reach a foot in thickness and no distinctly sandy band is of sufficient magnitude to assist or confuse in the determination of horizons. No layers have been found to be continuously fossiliferous, but many of the sandstones and a few of the shaly beds contain fossils quite abundantly for a short distance.

Of the fossils observed in the strata between the Grimes sandstone and the High Point sandstone the following are noteworthy.

The state museum record numbers attached to the species named signify localities in these layers as follows:

2429 Above Damm's vineyard, West hill
2430 Above Cleveland's, West hill
2431 Above Freed's, West hill; 250 feet above Grimes sandstone
2432 Worden hill, South Bristol, 200–300 feet above Grimes sandstone
2433 Roadside near Charles Sutton's, West hill, Naples
2434 West Italy, Yates county
2435 Powell hill, 2½ miles north of Naples; 250 feet above Grimes sandstone

Ambocoelia umbonata, 2430, 2431, 2432, 2433, Deyo basin 250 feet above Grimes sandstone
Spirifer mucronatus var. posterus, 2431, 2433, Deyo basin
S. mesastrialis, 2432
S. disjunctus, Deyo basin
Stropheodonta cayuta, 2431, 2432
Schizophoria impressa, 2431
Atrypa hystrix, 2431, 2432, Deyo basin
Productella lachrymosa, 2432, Deyo basin
Liorhynchus mesacostalis, 2433
Grammysia elliptica, 2430, 2433
Cimitaria corrugata, 2430
Leptodesma robustum, 2431
Palaeotrochus praecursor, 2432
Hydriodictya cylix, Deyo basin
Ceratodictya annulata, Deyo basin
Hydnoceras tuberosum, 2434
H. variabile, Deyo basin
Arthracantha depressa, 2429, Deyo basin

The flags and shales in which these brachiopodous faunules are found are stratigraphically equivalent to that part of the Gardeau flags and shales exposed on the Genesee river between Wolf creek and the top of the upper Portage falls. Structurally they differ very little from the undoubted Portage beds below, or the equally unquestioned Chemung strata above them.

Lithologically and stratigraphically the 600 feet of strata between the Grimes sandstones and the High Point sandstones can be correlated only with that part of the Portage section termed Gardeau, but paleontologically they bear no trace of the Portage or Naples fauna and on the other hand an abundant presentation of the Chemung fauna with the exception of a few feet of deposits at the base of the Grimes sandstones which represents an outrunner from the Ithaca fauna farther east.

At the top of these beds the proportion of arenaceous matter increases gradually and a band of heavy sandstones occurs in a stratigraphic position corresponding to that of the Portage sandstones at Portageville. The outcroppings of these sandstones about Naples are found at or near the tops of the hills in the vicinity and 900 to 1000 feet above the valley.

As the exposures are isolated from each other, and not extensive, none having been found that present an entire section of the formation, accurate measurement of the strata composing it is not practicable, but the heavy layers of sandstone are prominent in the bedding for 150 to 200 feet, closely resembling the Portageville rocks, but more frequently separated by beds of shale. The largest and most favorable exposure is in the cliff at High Point 2 miles west of Naples, at the elevation of 1700′ to 1800′ A. T., where about 75 feet of the sandstones and shaly partings appear in place in the escarpment and large blocks are scattered over the immense talus.

Situated about the middle of the section exposed is a calcareous lens 5 feet thick at the center, and 25 rods in breadth, composed almost entirely of fossils, of which 33 species have been identified (United States geological survey, Bulletin 16), 24 being brachiopods, none of which so far as known have been found in the Portage section on the Genesee river, nor below the Grimes sandstones in the Naples section. This constitutes the interesting High Point fauna which has been elsewhere described and shown to carry a marked representation of species present in the upper Devonic faunas of Iowa.

The diagram on the following page indicates the relative positions of the more interesting of the line of outcrops that show these High Point sandstones (station 1) to be synchronous with the Portage sandstones at Portageville (station 14).

Station 2. Wolf gully 3½ miles a little west of south from High Point. An escarpment at the top of the west bank is 30 to 40 rods long and shows 35 feet of rock mostly heavy sandstones. No fossils have been found here.

Station 3. ½ mile east of station 2, on the east side of Frink hill. An escarpment in which is a thin calcareous layer, composed principally of crinoid stems and bryozoans. Contains many brachiopods.

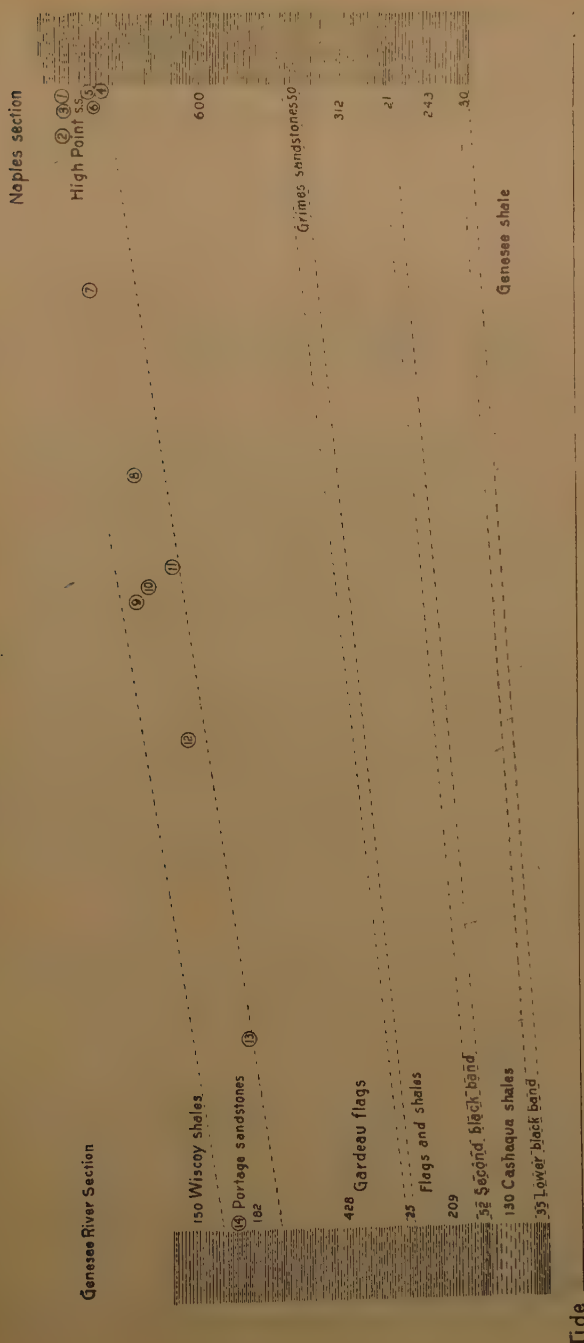
Station 4. Ledges on the west side of Knapp hill, 4½ miles southeast from High Point. A calcareous concretionary layer is crowded with D. tuberosum and Chemung brachiopods.

Station 5. One mile east of station 4 the sandstones appear in several small escarpments on north slope of Pine hill.

Station 6. McClarries's quarry on the hillside east of the village of North Cohocton. About 30 feet of light blue gray compact sandstones in heavy layers are exposed. A thin seam of shale in one of the hard layers contains a few small brachiopods. No other fossils appear. This quarry is evidently in the Portage sandstones but its stratigraphic position in them is not certainly known. It is 5 miles directly south of High Point and 30 miles east and 1 mile north of the cliff at Portageville. The altitude is 1575′ to 1600′ A. T., indicating an elevation of 300 feet to 400 feet or a westerly dip of 10 feet to 13 feet a mile, and a southward dip of 25–30 feet a mile.

Station 7. A small exposure near the foot of the hill on the north side of the road leading from North Cohocton to Wayland, a little east of Dotys Corners. It is about 4 miles west from station 6 and there is not much difference of altitude. A calcareous layer, similar to the one at High Point, but thinner, is composed of Chmeung brachiopods.

Station 8. Quarry 2 miles west of Wayland on the north side of the road to Dansville. Altitude about 1400′ A. T. No fossils have been observed here.


Naples section
High Point s.s.
600
Grimes sandstones 50
312
21
243
30
Genesee shale
Genesee River Section
150 Wiscoy shales
Portage sandstones
182
428 Gardeau flags
25 Flags and shales
209
52 Second black band
130 Cashaqua shales
35 Lower black band
Tide

Station 9. Schubmehl's quarry 1½ miles northeast of Dansville village. About 60 feet of strata, mainly heavy sandstones are exposed. Some soft shales at the top contain Manticoceras oxy and seem to indicate that the sandstones belong to the upper part of the formation. Altitude 1360′ to 1420′ A. T. This quarry is 18 miles due east of the cliff at Portageville. The only fossils observed were a small Orthis, Cladochonus, crinoid stems and plates, plant remains and F. verticalis. Hydnoceras tuberosum and a few brachiopods occur in a layer of flaggy sandstone that outcrops 1 mile farther north and 325 feet lower.

Station 10. Exposure along the Pittsburg, Shawmut and Northern railroad between 3 and 4 miles south of station 9, and 1 mile north of Rogersville station. About 50 feet of heavy sandstones outcrop in this vicinity. No fossils observed here.

Station 11. In Stony brook and two small lateral ravines about a mile south of the high Stony Brook bridge. Hydnoceras tuberosum occurs in the lower part of the sandstones exposed in the main ravine below the highway bridge.

In the Stony Brook ravine at the high bridge and below to its mouth, about 375 feet of strata are exposed. They show no appreciable difference in lithologic character nor in the contained fossils from the same horizon in the river sections. No brachiopods were observed here but the normal Portage fauna is found in the soft layers.

Station 12. An exposure of about 50 feet of the sandstones ½ mile east of the village of Byersville, in which a thin layer afforded several specimens of Atrypa aspera, a small Orthis, Cladochonus, etc.

Station 13. The outcrops on Quarry hill, 1 mile south of the village of Nunda. About 35 feet of the sandstones are exposed and a shale bed 6 feet thick of the same character as the one occurring a little below the middle of the sandstones at Portageville. A few goniatites and orthoceratites have been found in this shale, and about 25 feet higher a mass of crinoid stems and comminuted shells, in which only a small Chonetes is entire,

was observed. This locality is 5 miles east of the type locality at Portageville, station 14.

West of the Genesee river the normal Portage fauna, with a few additional species embraces all the fossils found up to the horizon of the sandstones.

CONCLUSION

The foregoing statement of facts demonstrates that during the time required for the deposition of 428 feet of upper Gardeau shales and flags, 182 feet of Portage sandstones and 150 feet of overlying Wiscoy shales in the Genesee river section, the normal Portage fauna continued to hold the ground while in the Naples section at the beginning of this period the succeeding fauna had advanced from the east, established itself and remained, driving out the Portage fauna which never returned.

The advance of the later invader toward the west was very slow, and probably broken by periods of recession, for in all that time it covered but 25 of the 30 miles between the two sections.

The upper limit of range of the Portage fauna descends in the strata, very irregularly doubtless, from the top of the Wiscoy shales above Portageville to the bottom of the Grimes sandstones at Naples, a vertical decline in the strata of 760 feet in a distance of 30 miles.

Postscript note by J. M. Clarke. The fauna of the beds in the Naples section, lying between the horizon of last appearance of the Naples fauna, stated by Mr Luther to be just below the base of the Grimes sandstone and the High Point sandstone, can not be properly construed as a Chemung fauna. The list of species cited from this thickness of 600 feet contains species which in a measure occur in Chemung faunas but Spirifer disjunctus is absent below the High Point horizon and none of the molluscan species are foreign to the higher Ithaca fauna pertaining to the Portage province adjacent on the east. The frequent Dictyosponges are more of Chemung habit but these bodies (Hydnoceras, etc.) got their foothold in western New York directly after the disappearance of the Naples fauna, and did not become freely disseminated in the more eastern Chemung deposits. Thus in the correlation of the faunas of the Naples section with those of the Genesee river we may say with approximate accuracy that in the latter the Naples or typical Portage fauna ranges through all beds from the top of the Genesee shales to the top of the Wiscoy shales (Cashaqua, Gardeau, Portage, Wiscoy), a thickness of 1211 feet. In the Naples section this fauna first appears briefly in the Genesee shales, temporarily disappears, reappears with the deposition of the Cashaqua shale and continues through a thickness of 600 feet of sediment. It is then driven out by an invasion from the east of the Ithaca fauna which held the field while the sediments equivalent to the middle and later parts of the Gardeau flags were deposited, and this congeries penetrated part way across the interval but did not reach the Genesee valley. Compared with the eastern development of the fauna in its proper province, it was comparatively few both in species and individuals. After holding the field during the most of the stage of Gardeau deposition it was displaced by the incursion of the Chemung fauna with Spirifer disjunctus, whose earliest presence was contemporaneous with the desposition of the Portage sandstones. This fauna did not reach the Genesee river till, as stated by Mr Luther, the horizon

of Long Beards riffs was reached, 150 feet above the Portage sandstones. So far then as pertains to the aspect of the faunas in these and intervening sections the following diagram indicates the mutual relation.

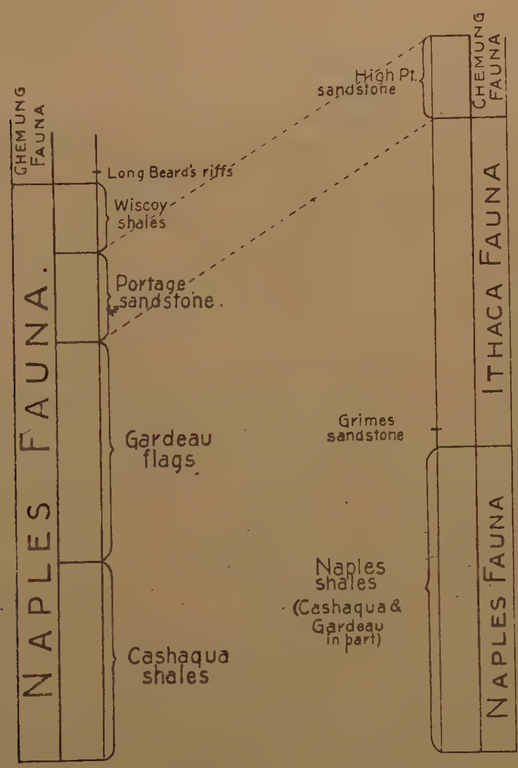


Plate 9

Map showing Paleozoic barriers in eastern North America.

PALEOZOIC SEAS AND BARRIERS IN EASTERN NORTH AMERICA[1]

BY E. O. ULRICH AND CHARLES SCHUCHERT

The following brief statement of the results of a series of important determinations in Appalachian geology anticipates a fuller discussion of the abundant facts on which they are based and which we hope to publish before the close of another year.

For more than half a century the problems for which it is believed a rational solution is herewith tendered, have engaged the attention of North American geologists. All who have worked on any part of the Appalachian region have observed a great difference in the stratigraphic succession as soon as they entered the area lying just west of the Appalachian protaxis. However careful their investigations, something has remained to be explained, and many ingenious suggestions were offered, without, save obscurely in one instance, attaining the true solution. Stratigraphic continuity was assumed, and the more fragmental character of the sediments along the western flank of the protaxis was believed to indicate little more than proximity to the eastern shore line of the interior sea, while the interruption in the gradual change eastward in the character of the deposits was generally ascribed to overthrust faulting.

But these explanations satisfied neither the stratigrapher nor the paleontologist, and they were accepted only because no better solution of the difficulties was at hand. The fact is, they did not explain and were mere makeshifts, necessitating one assumption after another as detailed mapping progressed.

Apparently the accepted solution did not satisfy that excellent stratigrapher, Sir William Logan, who, in checking the results of his investigations, enjoyed the advantage of close association with so careful and able a paleontologist as E. Billings. With a little more light Logan might have grasped the full significance of the stratigraphic discordance prevailing so constantly

[1] Published by permission of the director of the U. S. geological survey and of the secretary of the Smithsonian institution.

between the deposits lying to the northwest and southeast of the westernmost of the Appalachian series of overthrust faults in New York and Canada. Indeed, he did recognize, so long ago as 1866, that this overthrust marked in Canada the divisional line between two basins, an eastern and a western.[1] Though we regard the correlations based on this view by Logan, as well as the data from which the idea itself grew, as being at variance with the facts, his suggestion of distinct basins, it seems to us, was far too important to deserve the oblivion to which it has been assigned for all these years.[2]

Though abundant corroborative evidence of the existence of a narrow barrier between the stratigraphically inharmonious areas is afforded by the structural geology of the region in question, it was perhaps scarcely to be expected that the geologists who attacked the problem chiefly or solely from that side would find the true solution. It required detailed paleontologic knowledge, particularly as to assemblages of fossils and their geographic distribution, before the faunal distinctions indicating separate provinces could be appreciated. Had the geologists engaged on southern Appalachian problems received a suggestion from the paleontologists of the striking dissimilarity marking the faunas pertaining to the lithologically equally dissimilar Ordovicic rocks lying respectively on the east and west sides of the Great Valley, it is scarcely conceivable that they would have failed to grasp the leading facts in the case.

Excepting Walcott, who, however, confined his fruitful comparative studies to the Cambric, it appears that no paleontologist having sufficient knowledge of the Ordovicic faunas of the interior, and accustomed to fit his biologic results to stratigraphy, paid much attention to these problems.

[1] Geol. sur. Newfoundland. Rep't 1864; also reprint in 1881, p. 47.

[2] This theory of Logan's was brought to the attention of the authors but a few weeks ago. Occurring as it does as a note appended to Murray's report, it is not to be wondered that paleontologists remained in ignorance of its existence.

In 1897 and again in 1898, Mr Ulrich made small collections and brief stratigraphic investigations in east Tennessee. The fossils then collected were worked up in leisure moments during the next two years, and, when at last the results were brought together, the suspicion that the Upper Ordovicic strata in the eastern half of the Appalachian valley represent a different geologic province from those along its western edge, had grown to conviction.

The theory, however, was as yet undefined and hazy in its application, requiring much reading and field work to establish the character, position and extent of the barrier that separated the two basins or provinces. The paleontologic evidence in hand indicated a barrier of great length, dividing off from the interior sea a long and narrow body of water in which sediments were laid down containing remains of faunas having relations to those pertaining to east Canadian and European deposits rather than to those of the interior sea.

American, Canadian and European literature likely to bear on the questions involved, made a pile so imposing that without help the publication of the discovery must have been delayed indefinitely, had the work been undertaken by a single person, or it must have been brought out insufficiently supported by facts to demand credence. Mr Schuchert therefore undertook the labor of collating facts from published works, while Mr Ulrich continued the more congenial task of gathering additional evidence in the southern Appalachian field. Between us then, the evidence has been carefully weighed, discussed and correlated, our original theories being constantly modified and brought into accord with accruing facts till, finally, we entertained sufficient confidence in the general truth of the proposition to submit the following summary of results.

The Appalachian series of folds, of which those only that subsequently formed barriers, are discussed in this paper, probably trace their origin to precambric times. Walcott,[1] we believe, clearly demonstrated the existence of a long trough that dur- Lower Cambric trough

[1] U. S. geol. sur. Bul. 81. 1891.

ing Lower Cambric time extended from Alabama northeast to Labrador. It was evidently a synclinal fold—perhaps it would be better to call it a synclinorium—within the southeastern border of a very large Algonkian continent. After the close of the Lower Cambric, this old continent seems to have been subjected to a slight elevation, whose effect, however, made itself manifest principally in the eastern part. Here the Appalachian trough was almost drained of its sea, which appears further to have been confined to the western half of the original trough by the emergence of a fold.

St Croix invasion and birth of Mississippian sea

However, long before the close of the Middle Cambric, as at present defined, a second period of subsidence set in, submergence beginning along the east side of the Rocky mountain protaxis, and spreading northeastward. This submergence, which might be appropriately called the *St Croix invasion*, marks an important event in the development of the present continent, this being nothing less than the birth of the great interior continental sea, to which Walcott[1] has applied the term Mississippian. This sea, sometimes almost oceanic in extent, continued, with some interruptions and more frequent modifications of its outline, through all Paleozoic time. In Mesozoic time it was greatly reduced and restricted practically to the Great Plains region.

With the beginning of the Upper Cambric, which, however, had been preceded by a period of partial reemergence and at least local erosion of the old Lower Cambric land, specially in the southwest, the new sea had transgressed beyond the Adirondacks and soon thereafter probably effected communication with the Atlantic by way of the northern end of the restricted Appalachian trough, or, as this portion might be

St Lawrence channel

more appropriately called, the *St Lawrence channel*.[2] This communication with the Mississippian sea either continued through the Upper Cambric and the following Beekmantown age, or it was interrupted and revived again in the latter time. Only once thereafter, i. e. in the Utica age, did it serve the same

[1] Am. ass'n adv. sci. Proc. June 1894. 42:129-69.

[2] Mr Matthew finds this Dicellocephalus fauna common to America and Europe. See Trans. Royal Soc. Canada, 1893, v. 10, § 4, p. 11.

purpose. A slight transgression in Normans kill time is not taken into account.

Except around certain areas, composed of precambric rocks and supposed to have been islands—notably the Adirondacks of New York and a similar though probably less elevated area lying mainly in Wisconsin—where the deposits were arenaceous, the Upper Cambric sea laid down great beds of limestone. These limestones are chiefly dolomite, and, in this case, indicate 1) remoteness from steep shores of the areas receiving them, 2) considerable depth of water, which may explain the unusual paucity of animal remains contained in them, and 3) chemical precipitation as the main source of the matter composing them.

Upper Cambric limestone

As far as we can learn, it is only in the regions where Upper Cambric deposits are decidedly arenaceous, as in New York, that there is any marked distinction between them and the succeeding strata of the Beekmantown age. Where they are made up of limestones, like the Shenandoah and Knox formations of the Appalachian valley, the Arbuckle limestone of Indian territory, and the Pogonip limestone of Nevada, it appears that sedimentation and probably subsidence continued with little, if any, marked interruption from practically the beginning of the Upper Cambric to the close of the Beekmantown.

Beekmantown limestone

The close of the Beekmantown, however, marks the inauguration of a new arrangement in eastern North America. First, a fold was developed nearly parallel with and presumably a little within the western border of the original Lower Cambric trough; second, another fold, that we have already alluded to as having emerged early in Middle Cambric time, and that was now only accentuated, and reemerged, arose along a line marked in the south by the present western outline of the Ocoee series of rocks and in the north by the Green mountains of Vermont. Though these folds extended apparently without serious interruption from Alabama to and far beyond Quebec, it is doubtful whether the trough bounded by them was ever again entirely submerged subsequent to Beekmantown time. Between them, the western one in the southern and

Era of folding

northern parts, the eastern one in the middle part of the Appalachian valley, they constituted, if we except the Normans kill and Utica transgressions and the Devonic intervals of local submergence, an effective barrier between the interior continental or Mississippian sea and the Atlantic, to the final emergence of the entire Appalachian region.

Barriers named

The western of these two folds, whose geographic position is indicated on the accompanying map, we shall call the *Appalachian valley barrier* or fold, while the eastern is called the *Chilhowee barrier* or fold, when we refer to the middle portion and lower end of the uplift, and the *Green mountains barrier* in speaking of its northern end.

Coincident with the emergence of these folds, the Mississippian sea was restricted to narrower limits, but at present it is not safe to indicate the extent of the land areas then formed. Still it seems certain that, with the exception of the Chazy basin and Levis channel defined in the following paragraphs, all of New York was above sea level.

Appalachian valley trough

The space between the two folds we shall refer to generally as the *Appalachian valley trough* or simply *Valley trough*, and, in order to facilitate reference and geographic accuracy, it is divided into three unequal parts. The southern third, extending from Alabama to southwestern Virginia, we shall refer to as the *Lenoir basin*, the middle third, extending on to New Jersey, forms part of the subsequent *Cumberland basin*, and the northern third, extending as far as Newfoundland, will be called the *Levis channel*. Parallel with, but shorter than the Levis channel, and immediately northwest of the Appalachian valley barrier, lies the *Chazy basin*, with its typical Chazy deposits and fauna.

As will be seen later, these divisions are distinct though indefinitely bounded basins, of which the central one was commonly occupied by the Mississippian sea, while the terminal basins were generally taken up by Atlantic waters.

Immediately following the emergence of the folds and the broader land area just mentioned, there began a period of sub-

sidence, whose earliest effects, so far as marine deposition is concerned, are seen in the Chazy limestone of the northeast and the lower Stones river formations of Tennessee and Kentucky. In the latter regions the subsidence continued, without serious interruption, to the close of the Black river, when elevation, resulting in the first emergence and subsequent erosion of the Cincinnati and Nashville domes or *parma* of Suess, took place. In the meantime, the Mississippian sea, which seems to have entered from the south, was steadily advancing northeastward, reaching the Mohawk and St Lawrence valleys, as we shall have occasion to explain more fully, just before the close of the Stones river age. Stones river invasion

With the earlier part of this subsidence, the Atlantic invaded the continent westward by means of the two subparallel and closely approximated channels that we have called the Chazy bay and the Levis channel. The former extended along the northwestern side of the Quebec barrier, which separated the two channels, up the St Lawrence to the northeast angle of the Adirondack mass, where it divided, one arm entering the Ottawa basin, the other passing on up the Champlain valley to or about Westhaven. The typical Chazy formation, which represents the deposits of this bay, bears evidence in its members of having encroached southward and westward in the arms, the latest beds, except where, apparently, they were removed before being covered by the next formation, extending farthest south and west. Chazy invasion and bay

The Levis channel, which occupied the narrow trough between the Quebec and Green mountains barriers, extended from Newfoundland southwestward as far at least as Rensselaer county, N. Y., where Ruedemann has found the typical Levis fauna. Its deposits consist almost wholly of shales, with occasional rather local thin bands of impure limestone and accumulations of conglomerates, as at Levis opposite Quebec city. The faunas, which in their general aspect are decidedly European, consist mainly of graptolites, that of the Levis formation being particularly characterized by several species of Phyllograptus. The respec- Levis channel

tive faunas and the lithologic character of the deposits in the twin channels are so different that we can not doubt the thorough effectiveness of the Quebec barrier during the whole of Chazy time.

Lower Dicellograptus fauna

At the close of the Chazy the northwest channel, and perhaps the Levis channel as well, was drained. This emergence continued in the Chazy basin till Black river time, but, if the drainage occurred simultaneously in both channels, appears to have been of briefer duration in the Levis channel. On the other hand, it seems very likely that the Chazy bay was emptied sometime in advance of the Levis channel, allowing deposition in the latter of beds holding the lower Dicellograptus and Agnostus, Ampyx, Aeglina and Paterula fauna, which is common to Europe and the Levis channel. The earlier emergence of the Chazy channel is rendered very plausible if we assume a period of compression at the close of the Chazy, causing the strata in the western channel to be pushed up on the sloping Adirondack and Laurentian masses beneath them, and high enough to empty the western channel but not the Levis channel. The same assumption would explain the development of the supposed barrier, referred to a page or two farther on, across the mouth of the Ottawa arm of the Chazy bay, which, if it ever existed, must have arisen about this time.

The deposits and fauna of the supposed lower Dicellograptus zone in the Levis channel are now known chiefly, if not solely, from limestone pebbles and boulders preserved in the conglomeratic horizon at the base of the Normans kill shale, the bed itself possibly being now entirely covered by overthrust Cambric rocks. The fauna contained in these pebbles, as worked out by Ruedemann,[1] contains species indicating some communication with the Mississippian sea in the vicinity of Albany N. Y.; or it may be that the sea of the Normans kill shale, which transgressed farther westward, also washed surfaces laid down by Black river and early Trenton seas.

Normans kill shale

The Normans kill shale, which, as we have just said, transgressed a little farther west, also extended farther southward

[1] N. Y. state mus. Bul. 42. 1901; Bul. 49, 1902. p. 89-94.

in the gradually submerging Appalachian valley trough into New Jersey[1] and probably across the Delaware into Pennsylvania, where, according to Weller, it rests on Lower Trenton or Black river limestone. If this succession is normal, then we have a good indication of the age of the Chazy, and again of the later strata containing the distinctively European fauna characterized by Paterula, Christiania, Agnostus, Ampyx and Aeglina. The latter must be older than the Black river and younger than lower Stones river, the latter of which we consider about equivalent in time to the Chazy and Levis. Following the same line of reasoning, we see that the Chazy of the Champlain-Quebec valley and the Ottawa basin was succeeded by an interval of elevation and probable erosion preceding the Black river invasion. Again we conclude, the upper limit being fixed by evidence touched on in a succeeding paragraph, that the Normans kill shale is about Middle Trenton, as demonstrated by Ruedemann, or a little later in age.

While the Chazy and the greater part of the Stones river deposits were being laid down elsewhere, nearly all of the middle Appalachian area, together with New York and much of Canada north of the St Lawrence, constituted a great and continuous land area, and it was only with the advent of the Black river and the underlying Lowville limestone, which is equivalent to the extreme top of the Stones river, that the Mississippian sea at last spread over a considerable part of this territory. Judging from the uniform age of the basal member of the Mohawkian in New York and Canada, it seems almost certain that the Black river sea accomplished the submergence of the troughs surrounding the Adirondacks and lying south of the Laurentian nucleus, or Canadian *shield* of Suess, almost simultaneously. It is therefore eminently proper to speak of this stage of the subsidence as the Black river invasion. **Black river invasion**

The Trenton sea seems to have maintained very nearly the same outline here as the Black river, and like that sea, at first, and then again near the close of its age, transgressed the Quebec

[1] Weller. Geol. sur. N. J. An. rep't, 1900. p. 5; and Kümmel, p. 53.

barrier so as to occupy the northern third of the valley trough from the mouth of the Mohawk to Montreal. Beyond the latter point to Quebec both the Black river and Trenton deposits were probably confined to the area covered by the former Chazy bay.

Trenton transgressions eastward

Between the two Trenton transgressions the Normans kill shale intervened, its western edge overlapping the first and being in turn covered by the second. The latter eastward transgression of the Trenton is indicated chiefly by the fauna of the calcareous shale overlying the Normans kill. A careful study of Mr Ruedemann's list of this fauna reveals nothing incompatible with a late Trenton correlation.

Ottawa bay

Immediately succeeding the Chazy, there is reason to believe, a fold was developed across the mouth of the Ottawa bay that has since been worn down to Upper Cambric rocks. This fold must have been higher than the land formerly bounding the western end of the bay and separated a new Ottawa bay now coming in from the west, probably by way of Lake Nipissing, from the narrow Champlain-Quebec basin. This separation is indicated by both structural and paleontologic evidence.

Utica invasion

At the close of the Trenton the Cincinnati axis or *parma* experienced one of its periodic uplifts, and with it much of the area west of it was raised above sea level. The region to the east of it and north of the Ohio river, on the contrary, seems to have been slightly depressed. Apparently the subsidence was greatest in the Mohawk valley and in the Levis basin of the Appalachian valley trough, and sufficient to render the Quebec barrier wholly ineffective here. The northeast communication with the Atlantic, now considerably enlarged by the subsidence, brought in with the decided southwest current, ingeniously demonstrated by Ruedemann,[1] a fauna wholly new to the Mississippian sea, having, as has been already asserted by Matthew and more recently by Ruedemann,[2] strong European affinities.

---

[1] Am. geol. 1897. 19:367-91; 1898. 21:75-81.

[2] N. Y. state mus. Bul. 42. 1901. p. 562.

This communication with the Atlantic through the St Lawrence continuation of the Appalachian valley trough was, however, not of long duration, nor did the foreign element of the Utica fauna impress itself to any appreciable extent in the development of succeeding faunas of the Mississippian sea. A slight elevation and it ceased, the preceding Trenton life condition being reestablished.

The first deposits laid down in the Mississippian sea, following the return to the Trenton arrangement of parts, are the Frankfort shales, which we regard as equivalent to the Middle and Upper Utica of Nickles's Cincinnati section,[1] the typical Utica barely reaching that point, though something like 300 feet thick in northwestern Ohio.

Frankfort shale

The Lorraine sea extended eastward into the Mohawk valley of New York only as far as Rome, being there limited by a low north and south fold, that later on becomes conspicuous again as the western limit of the Helderbergian invasion. The Lorraine of the Hudson river valley has been shown by Ruedemann to be the equivalent of the Frankfort shales with a fauna transitional from the Utica to the higher Lorraine.

In the north the effect of the lateral compression to which the Appalachian region was periodically subjected during the Paleozoic is particularly marked in the area lying just east of the Adirondack mountains. The Ordovician sediments here were piled in distorted and broken masses and largely covered by overthrust Cambric deposits. As might be expected, the eastern one of the two (Chazy and Levis) channels that intervened between the Adirondacks and the Green mountains has been almost obliterated, so that it is now very difficult to trace out the relations of the remnants of its deposits, which crop out only here and there from beneath the overthrust masses of older rocks. Still, with careful stratigraphic and paleontologic comparison, we believe the task is not hopeless. Ruedemann's important results about Albany, Ami's recent work at Quebec, and Dale's careful areal work, look, to say the least, encouraging and augur even greater results in the near future.

Maximum of compression east of Adirondacks

[1] Cincinnati soc. nat. hist. Jour. 1902. 20:49-100.

Having described the Ordovicic conditions that prevailed in New York, and the bearing of the Appalachian barriers in their development, we turn to a briefer discussion of the conditions obtaining at the same time in the regions containing the middle and southern thirds of the Valley trough.

While the Chazy and succeeding Ordovicic deposits were being laid down in the north in waters having direct communication with the north Atlantic, another series of rocks was in course of deposition in a bay separated from the Mississippian sea by the

Rome barrier and Lenoir basin

Rome barrier, which is the sharply defined southern extension of the Appalachian valley fold. This bay may take the name of *Lenoir*. It communicated with the Atlantic at its southern end and extended northeastward between the Rome and Chilhowee barriers from middle-eastern Alabama to southwestern Virginia.

Athens and Knoxville troughs

The Lenoir bay occupied a synclinorium containing several disconnected longitudinal folds high enough to affect the direction of currents and consequently the character of the sediments and, in a smaller degree, faunal distribution. In a general way the deposits may be divided into an eastern (*Athens trough*) and a western series (*Knoxville trough*), the members of which, on account of differential warping and subsidence, and lateral conjunction, overlap or grade into each other along the shifting median line. On the eastern side we have the Athens shale and sandstone, which are supposed to correspond with the Lenoir limestone of Safford (in part the same as the Chickamauga limestone of Hayes, Campbell and Keith), and its great lenses of Holston marble

Correlation of Ordovicic deposits in Lenoir basin

occupying the western half. Compared with the sediments in the northern Appalachian troughs (Chazy basin and Levis channel), they probably fill the interval there occupied by the Chazy, Levis and Normans kill shale. The Tellico sandstone and the Moccasin limestone follow, the former in the eastern half, the latter in the western, while the Sevier shale spreads over both sides. The last formation probably is equivalent in time to late Trenton and, possibly, Utica.

These Lenoir bay deposits contain faunas wholly distinct from those pertaining to the true Chickamauga limestone series, which

was deposited at the same time and in great volume along the western side of the Great Valley of east Tennessee by the Mississippian sea, from which the bay was separated by the narrow Rome barrier. The Chickamauga limestone embraces in this region unmistakable representatives of every important member of the sections of middle Tennessee and central Kentucky, ranging from the base of the Stones river to lower Lorraine; and the Stones river divisions are particularly characteristic. Chickamauga limestone

Elevation of the Lenoir basin now (presumably at close of Trenton) took place, bringing in a very different arrangement. The elevation was greatest at the southern end, thus cutting off all communication with the Atlantic. At the same time the middle third of the Valley trough sank, allowing the waters of the Mississippian sea, which, at least from Black river time on, occupied the middle third, to invade southwardly into the former confines of the Lenoir bay. The result of this revolution and invasion is the Bays and Clinch sandstones, and the lower, nonferruginous, shale division of the Rockwood formation, all of which, as is indicated by fossils collected from the last by M. R. Campbell, of the U. S. geological survey, are of Cincinnatian (perhaps Lorraine) age. Continued elevation of the southern end of the Valley trough is indicated by the fact that of the three formations mentioned the first extends farthest south, the second not so far, and the third again falling short of the Clinch. Bays and Clinch invasion

Before the close of the Ordovicic both the Lenoir bay and the Cumberland basin had been raised above sea level. This emergence took place about the beginning of the Richmond age, during which the Mississippian sea was restricted to the Ohio valley and west and south of the Cincinnati line of uplift. Prior to this time, or at the beginning of the Lorraine, which probably corresponds very nearly to the time of the Bays and Clinch invasion described in the preceding paragraph, there was another emergence that reduced the Frankfort phase of the Mississippian sea by excluding its waters from the valley of the upper Mississippi and from the various basins lying east and south of Rome N. Y. We see, then, that both of these emergences were ac- Richmond emergence

companied by a submergence, the older taking place, as we have described, in the region of the middle third of the Appalachian valley, the later one in the west, where the preceding Lorraine land was again submerged.

Richmond submergence

The Richmond submergence is of great importance in the geologic history of the North American continent, fossil evidence bearing on the point indicating open communication of the entire Mississippian sea, then existing, with Anticosti and northern Europe. But as this communication was certainly not by way of the St Lawrence-Champlain valley, and the problem therefore is not intimately connected with the subjects of this paper, its discussion is deferred.

Toward the close of Ordovicic time the lands and seas, as evidenced by the two Lorraine and Richmond emergences and submergences described, had become unstable. Now followed one of the greatest earth pulsations in North American Paleozoic history. The disturbance referred to, Dana[1] says gave birth to the Taconic mountains; and we will therefore call it the Taconic revolution. That this movement was one not only of elevation but also of considerable folding of the earth's crust, is shown in the fact that the Helderbergian deposits overlie unconformably the Ordovicic strata, as at Becraft mountain, New York. That its effects were extensive is indicated by Dana's remark, "The Taconic . . . series of upturnings appear . . . to extend all the way from the St Lawrence valley to New York city."

Taconic revolution

This revolution affected all North America, and there was land perhaps throughout from Richmond to Oneida time. The length of this land interval we can not perhaps now ascertain satisfactorily, because there are no Mississippi sea deposits by which its duration may be measured. In Minnesota, and more particularly in Manitoba, there are late Ordovicic deposits with prophetic Siluric genera and species which apparently indicate that the land interval was not of long duration. "After a mountain birth," says Dana,[2] "there has commonly succeeded a time

[1] Manual of geology. Ed. 4. 1896. p. 386 and 531.

[2] Manual of geology. Ed. 4. 1896. p. 386.

of relaxed lateral pressure; and then occurred adjustments, largely by gravitation." Certainly this is true in this instance, for after the subsidence had commenced it continued nearly through all Siluric times.

The Oswegan subsidence or invasion, as it may be called, began with the Oneida and continued with little interruption to the close of the Salina age. In New York these deposits thin out eastward, and one after the other formation overlaps the older, so that in the region south of the Mohawk river the Eurypterus bearing Waterlime, which is the uppermost division of the Salina, appears not to have reached the eastern side of the Helderberg mountains. The Clinton, Niagara and Salina also pinch out one after another west of the Helderberg mountains. To the south, the equivalent deposits transgress even less toward the Appalachian protaxis, the eastern line in middle Pennsylvania swinging westward to the vicinity of Altoona. From this point southwestward the line, judging from the data available, seems to have run about parallel with the general trend of the Appalachian folds into West Virginia, and it probably swung eastward again toward the Appalachian valley fold before passing through that state. This westwardly bent line has great significance, because it corresponds with the course of a barrier defining the western limit of another basin, the *Cumberland basin*, that was occupied by an Appalachian Mediterranean, with a fauna very different from that of the contemporaneous Mississippian sea. We mention this a little out of the regular order of our description, so that the reader may understand why the Siluric deposits east of the Helderbergian barrier just located are not regarded as continuations of the sediments of the Mississippian sea.

Oswegan invasion

Cumberland basin and Helderbergian basin

In the southeastern portion of the Mississippian sea the Oswegan invasion was limited by the Rome barrier, and began with a shale instead of conglomerate and sandstone. This character of deposits continued with occasional interruptions of thin, ferruginous, fossil limestones, and locally heavier beds of sandstone, to the close of the Clinton. There are no deposits of

Rome barrier in Siluric

Niagara, nor of any later Siluric age in east Tennessee, unless the Niagara is represented in the extreme upper part of the Rockwood formation, the shales and sandstones of this formation being as a rule succeeded in this area by the Devonic Chattanooga shale. The existence of a land surface, extending westward from the protaxis across east Tennessee to the western slope of the middle Tennessee dome, therefore is assumed as filling the interval between the close of the Clinton or early Niagara to the middle Devonic. The Cincinnati dome also was above sea level at the same time, and connected with the east Tennessee land in such a manner that a broad bay was left between the two domes. Neither of the latter was ever covered entirely by Siluric strata, these being laid down only on their gently sloping shores and in embayments produced by slight warping of their surfaces. The succession of the deposits in these embayments shows very clearly that the emergence at the close of the Clinton was soon checked, and that gentle subsidence prevailed in later Niagara time.

Siluric land in Tennessee and Kentucky

Throughout Cayugan time, on the contrary, the Mississippian sea was growing shallower, the floor of the sea having risen almost gradually till, at the close of the Rondout, the whole interior of the continent west of the Helderbergian barrier had become land. This important emergence, for which we propose the name *Cayugan*, continued from Waterlime to Onondaga time, when the Mississippian sea again came in from the southwest, spreading far and wide in the United States. In its eastward progression this invasion (Onondaga) did not reach middle and east Tennessee till near the close of the Black shale, which is commonly correlated with the Genesee. The southern Black or Chattanooga shale, however, may really represent late Devonic time only, since in complete sections the shale in question seems to pass very gradually into undoubted basal Mississippian (Carbonic) shales.

Cayugan emergence

Helderbergian invasion

While both the Oswegan subsidence and the following Cayugan emergence were affecting the area to the west of the Helder-

bergian barrier, mentioned above, the region east of the barrier, comprising the Cumberland basin, was steadily going down, the subsidence allowing an invasion of an Atlantic sea and fauna to which the name *Helderbergian invasion* may be very appropriately given.

This invasion brought in a European fauna by way of the *Hercynian chain* believed to have connected North America with central Europe (Bohemia, Hartz, etc.). We think this line is in the main correctly drawn by Bertrand,[1] though we would draw it on the American side more to the north—nearer to his *Caledonian chain*—so as to bring the Helderbergian and Oriskanian deposits of Gaspé, Quebec, into more direct connection with those of the Appalachian Mediterranean.

This invasion of the United States began early in Siluric time, occupying then and to close of Oriskany time the growing Cumberland basin lying, as described above, east of the Helderbergian barrier. The connection between this Appalachian Mediterranean and the Atlantic, which will be further discussed in treating of the Marcellus invasion and the Skunnemunk trough, is supposed to have been about in the region of Chesapeake bay. Appalachian Mediterranean, or Cumberland basin

To the north and south of Cumberland Md., there is a great series of rocks, beginning with shales and passing upward into limestone, and characterized by a succession of prolific faunas.[2] Very few of the species of these faunas are identical with species of the Mississippian sea of Siluric time. The earliest fauna recalls the Clinton, and passes into one which may be compared with the Niagaran, and then a great series of limestones, abounding in minute Ostracoda, which may be compared with the Salina on account of the prevalence here also of larger Ostracoda of the genus Leperditia. Then comes in without

[1] Soc. geol. de France. Bul. Ser. 3. 1887. 15:442.

[2] This series of rocks rests on the Tuscarora and Juniata formations. These coarse deposits have afforded very little satisfactory fossil evidence, so that we do not yet know whether they belong to the Mississippian sea or the Appalachian Mediterranean.

break the Decker Ferry fauna listed by Weller,[1] the Manlius, with a magnificent cystid fauna, among which is Camarocrinus in great abundance, followed by the typical Helderbergian and Oriskanian. The respective faunas of these formations may be gathered in the vicinity of Cumberland and southward for a hundred miles or more into the Virginias. Continuing in this direction, overlap causes the lower formations to wedge out one after another till, finally, only a little of the Helderbergian and Oriskanian series is represented in the Sneedville or Handcock limestone of southwestern Virginia and northeastern Tennessee. Northward from Cumberland, through Pennsylvania and New Jersey into New York, the lower formations pinch out in the same manner as in the south, so that in the Kittatinny valley of New Jersey it is practically the Decker Ferry formation only that rests on the "red and white Medina" or Shawangunk. From here north, however, the Decker Ferry, Manlius and Helderberg formations continue in full force to near the Mohawk river, presenting thus a condition differing widely from that obtaining in the southern end of the basin. It is in this northern area that one finds the extensive and readily accessible Helderbergian deposits that furnished the fauna so well described and beautifully illustrated by Hall. For this reason, and because the subsidence appears to have been continuous, we have chosen the name *Helderbergian* for the invasion. In the other cases of movements named by us, we have taken the name

[1] Geol. sur. of New Jersey for 1899. 1900. p. 7-21. Some of these identifications are admittedly provisional and require verification, Mr Weller having followed Hall's correlation of the Coralline limestone as the eastern representative of the western Niagara, an obvious error now that we know that the Coralline limestone lies just below the Rondout, at Rondout N. Y. However, the typical Rondout should not be confounded with the Waterlime of Buffalo N. Y. The Rondout formation is but the base of the Manlius, and the former is completely transitional downward into the Coralline limestone. The Helderbergian invasion in New York begins with the Coralline, while the Cayugan emergence closes with the so called "Clinton" of the Schoharie section, which we consider the overlapping eastern edge of the Salina deposits, and certainly not equivalent to the true Clinton.

from that of the formation introducing the movement, but in this case the formation that might claim that distinction has not been named nor has its fauna been described.

Helderbergian of Montreal, Gaspé and Dalhousie

The small Helderbergian outlier near Montreal[1] probably belongs with the Gaspé series, since there is no clear evidence that the Albany county, N. Y., area ever connected with Montreal by way of the Champlain valley, as was supposed by Logan and Dana[2] to be the case. About Gaspé there is a grand development of Helderbergian and Oriskanian, whose faunas are closely related to those of their equivalents in New York; and another area occurs near Dalhousie N. B., with a fauna peculiar to it. Concerning these two areas, the latter appears to belong to a subprovince distinct from that of the Appalachian Mediterranean.

The Helderbergian invasion of the southern Mississippi valley began after the Cayugan emergence, since its first deposit seems to be of Coeymans age. Part of the underlying Meniscus or Clifton limestone of Safford may also belong to this invasion. It came in from the south and spread north along the western side of the Cincinnati arch through Tennessee into southern Illinois and Missouri. The invasion continued throughout Helderbergian time and ceased with the Camden chert of early Oriskany age. Another area lies in Indian Territory, and the faunas of all the southern Helderbergian and Oriskanian deposits are of the Appalachian facies.

No Helderbergian deposits are reported from the Rocky mountain region, but we have good reasons for stating that equivalent deposits occur in the Devonic of the White Pine and Eureka districts of Nevada as defined by Walcott and Hague, holding a rather peculiar, though on the whole recognizably Helderbergian fauna.

Oriskanian emergence of Appalachian Mediterranean

The Oriskany formation in the Appalachian Mediterranean, or Cumberland basin is in full force only in the region to the north and south of Cumberland Md. In southern Pennsylvania,

[1] Schuchert. Am. geol. 1901. 27:245-53.

[2] Manual of geol. Ed. 4. 1896. p. 558.

Maryland, and thence south along Appalachia, the Oriskanian emergence continued to close of Onondaga time; and, as we have already described in considering the Cayugan emergence, affected not only the Appalachian Mediterranean but the southeastern area of the Mississippian sea as well. In middle Virginia emergence began early in Oriskany time, since no true or Upper Oriskany is known in southern Virginia or Tennessee. To the north of Cumberland Md. the Oriskany is unequally developed, but in eastern New York it appears to be the higher portion only that is present. With Lower Oriskany only in the southern extremity, and Upper Oriskany only in the northern end, the movements evidently were directly opposite at the two extremities of the Cumberland basin during Oriskanian time. The land conditions that succeeded the Oriskany in the Cumberland basin continued till about Marcellus or Middle Devonic time, when the later Devonic deposits of the Skunnemunk invasion were laid down.

Oriskanian invasion of the Mississippian sea

Immediately succeeding the Oriskany emergence of the Cumberland basin, there still remained in southern New York a depression through which the Atlantic fauna of the Oriskany invaded the Mississippian province. This invasion, coming in from the southeast (the Esopus, which is only a phase of the Oriskany, is 700 feet thick, according to Ries,[1] in Orange county, N. Y.) spread northward, over the Oriskany, and, after crossing the Helderbergian barrier at Rome, continued on westward by way of Buffalo, where remnants of it are seen in the cement quarries.[2] Finally, the last of this deposit is seen near Cayuga Ont.

Onondaga invasion

The Oriskanian invasion attained the last locality about the same time that the Onondaga invasion, coming in from the southwest, arrived there, the result being that the Onondaga and late Oriskany faunas, originally very dissimilar in character, became one, making together what is now known as the eastern Onondaga fauna.

---

[1] Ries. N. Y. state geol. 15th an. rep't 1897. 1898. 1:402.
[2] Grabau. Geol. soc. Am. Bul. 1900. 11:355-62.

The blending of these two different faunas can be seen to best advantage in the townships of Oneida and North Cayuga, Ont., where there is a sandstone filled with late Oriskany fossils. The sandstone rapidly passes into a sandy limestone and then into the typical Onondaga limestone. If it were not for the structural dissimilarity of the beds, these two faunas could not be separated, since it has been shown that out of 71 species found here, not less than 42 pass up from the lower horizon into the Onondaga;[1] yet the lower horizon has such characteristic Oriskany species as Spirifer arenosus, Chonostrophia complanata, Rhipidomella musculosa, Stropheodonta magniventra, S. vascularia, Eatonia peculiaris, etc. On account of the marked Onondaga aspect of its fauna, it is unwise to call this Ontario deposit Oriskany any longer, and we here propose to call it the *Decewville* formation, taking the name from the village nearest to its exposures. We include in the formation the coarse basal sandstone and the thin bedded sandy limestones up to where the typical Onondaga limestone appears.

A careful analysis of the Schoharie grit fauna of eastern New York, and of the Pendleton sandstone of Indiana[2] will probably also show a blending of the invading Oriskany and Onondaga faunas, though probably less marked than it is at Decewville Ont.

A further instance, or rather, a survival of the blending of the Oriskany and Onondaga faunas, is shown at Clarence Hollow N. Y., where Spirifer arenosus (described as S. unica Hall) occurs in the Onondaga limestone.

By the time the Onondaga invasion had become established in the Mississippian province, the Cumberland basin, including its last remnant, the Oriskanian channel already discussed, had been wholly emerged, thus cutting off all communication with the Atlantic in this region. This severance, however, was of

---

[1] Schuchert. N. Y. state geol. 8th an. rep't. 1889. p. 51-54. Also Geol. soc. Am. Bul. 1900. 11:323-26.

[2] Siebenthal. Ind. dep't geol. and nat. res. 25th an. rep't. 1901. p. 347.

short duration, lasting only, as we shall endeavor to show, till early Hamilton (Marcellus) time, when the subsidence, which in the meantime affected the greater part of the southeastern fourth of the continent, reopened the Oriskanian channel and, extending it eastward, allowed invasion from that direction. This Marcellus invasion produced considerable intermingling of the Atlantic and Mississippian faunas, specially in those laid down in the modified but resubmerged Cumberland basin.

Skunnemunk trough and formations in it

In the Skunnemunk and Green Pond mountain region, the former in southeastern New York, the latter in New Jersey, there is a series of coarse deposits apparently occupying a syncline. The oldest formation above the presiluric deposits is the Green Pond conglomerate, supposed to be of the age of the Shawangunk farther north. From this on, deposition appears to have been continuous to the close of the Helderbergian, when this area, in common with the Cumberland basin to the west of it, was affected by the elevation of the eastern side of the continent. Resubmergence began here with the Monroe shales,[1] which rest on Oriskanian strata, and continued through the Bellvale flags into the Skunnemunk conglomerate, which Darton suggests "may represent the Oneonta" or "the formation may be the equivalent of the coarse beds of the Chemung." Fossils from the Monroe shales sent by Darton to Hall were pronounced by the latter to be of "typical lower Hamilton (group) species."[2] The Bellvale flags contain Tropidoleptus carinatus, Spirifer mucronatus, and, more commonly, land plants, recalling those described by Dawson from the Gaspé sandstones. According to Ries the total thickness of the Devonic deposits (succeeding the Esopus or Oriskany) in the Skunnemunk and Bellvale mountains of New York, is about 1500 feet; while Darton gives a thickness of 5400 feet for the equivalent series in the Green Pond area of New Jersey. This difference in volume is cited in support of our opinion that the great-

---

[1] Darton. Geol. soc. Am. 1894. v. 5; Ries. N. Y. state geol. 15th an. rep't 1897. 1898. 1:403-4, 410-24.

[2] Darton, op. cit, p. 375.

Marcellus invasion

est depression of the Skunnemunk trough and the Cumberland basin was to the south of New Jersey, and there permitted the Atlantic during the Marcellus to spread its fauna across the Chilhowee barrier into the Mississippian sea.

These deposits were laid down in waters occupying a trough lying east of the Appalachian valley trough, and hold, as do also the equivalent sediments of the Cumberland basin, faunas having different aspects from those of the Devonic west of the Cincinnati axis. The communication between these basins or troughs and the Atlantic was, we believe, effected by channels corresponding in position to the present Chesapeake and Delaware bays. We believe further that it was through these channels that the Skunnemunk trough and the eastern Mississippian sea, the latter covering Virginia, Maryland, Pennsylvania and New York at the time, received its Marcellus accessions. These migrants are now found mixed together with the indigenous early Hamilton faunas as far west as western Ontario (Thedford). Some of these European accessions are Strophalosia, Liorhynchus, Tropidoleptus, Tentaculites, Styliolina, Actinopteria, Pterochaenia, Bactrites and Tornoceras.[1]

Our derivation of this fauna from Europe by way of the Atlantic goes further than Dr Clarke's views. He regards it "as an invader from the southeast along the inner or Appalachian face of the interior sea."[2] The Marcellus is well developed about Cumberland Md., and south to about central Virginia, where this formation pinches out. We therefore conclude that the invasion from the Atlantic was somewhere in the Chesapeake bay region. The bulk of the Marcellus fauna is however indigenous to the eastern Mississippian sea and is a development out of the Onondaga.

---

[1] We should not have been able to make these statements, had we not the excellent work of Dr Clarke on the Marcellus faunas. These papers are the following: N. Y. state geol. 4th an. rep't 1884. 1885. p. 11; N. Y. state mus. 42d an. rep't. 1889. p. 406-97; N. Y. state mus. Bul. 49. 1902. p. 115-38 and Miss Wood's paper following on p. 139-81.

[2] Ib. p. 115.

The Hamilton deposits of Michigan, Wisconsin and Iowa, however, belong to a distinct subprovince, and received their main accessions from another direction.

Portage invasion

We believe another Atlantic invasion of the eastern Mississippian sea occurred during early Portage time, introducing a good part of the very characteristic Naples fauna, as Manticoceras, Gephyroceras, Beloceras, Sandbergeroceras and Cyrtoclymenia. The goniatite fauna of this formation, according to Dr Clarke's[1] work, consists of no less than eight genera and 25 species, and yet in no other American area holding beds of similar age, occurs more than one species of goniatite. (Manticoceras intumescens, the widely dispersed European species, is also found in Iowa and on Hay river, latitude 60° north.) This fauna is closely related to that "of Martenberg in Westphalia."[2] How long this Atlantic invasion continued we do not pretend to state, but it is certain that the indigenous Upper Devonic faunas of New York not only received the above supposed Atlantic migrants, but also some from Iowa, as in the High Point (N. Y.) faunula. The Mackenzie basin Upper Devonic fauna, characterized by Stringocephalus burtini, is of a distinct subprovince; but the geographic derivation of that fauna we do not yet know. We are however satisfied these Mackenzie Devonic deposits had no direct connection with those of Iowa.

Carbonic[3]

There appears to be a complete series of Devonic deposits, with the possible exception of the Onondaga, in the middle third of the Appalachian Valley trough, but early Mississippian seems to be wanting in this portion. In the southern end, the early Carbonic, represented just west of the Rome barrier by the Fort Payne chert, also was partially excluded; but the St Louis, and possibly Chester, are represented in the trough at several points. The Fort Payne chert is represented within the extreme

[1] Am. geol. 1891. p. 86-105; N. Y. state geol. 15th an. rep't. 1898. p. 31-81; also ib. 16th rep't, extract. 1898. p. 31-143.

[2] Clarke. p. 136.

[3] For this section Mr Ulrich alone is responsible.

southern end of the trough by several small patches, in Polk county, Ga., some 20 miles north of Tallapoosa. These patches evidently are remnants of a tongue of this formation that extended northeastward to this point and occupied a syncline along the eastern side of the Valley trough, this particular syncline being now almost entirely covered by overthrust Ocoee slates and conglomerates. Its connection with the main body of the Fort Payne deposit is at present conjectural.

The shore line of the main body of the early Mississippian sea followed the western side of the Rome barrier rather closely to probably some point in Virginia, where it broke through the line and sent tongues southward in secondary depressions within the Appalachian valley synclinorium. These secondary depressions may in a general way be said to have been occupied at an earlier period by the sea which laid down the Devonic Black shale, and which entered the trough probably through the same opening. Subsidence of the middle third of the Valley trough continued in second half of Mississippian time, resulting in greater expanse in the Appalachian region of Newman limestone and Pennington shale, which, together, represent the St Louis and Chester deposits of the Mississippi valley. These formations, however, do not extend over much of the basinlike area occupied by the early Mississippian-Waverly sea in Ohio, northeast Kentucky and the adjoining corner of West Virginia, the Waverly basin, lying between the middle Tennessee-Cincinnati line of uplift and the Appalachian-Chilhowee barrier, having been in St Louis and Chester times, much reduced in its northern and northwestern extent.

The Carbonic strata of Michigan were deposited in a basin formed by the bifurcation of the Cincinnati axis, and probably had only a slender or possibly no direct connection with the Waverly basin to the southeast of it. At any rate, the evidence in hand indicates that, if the connection existed at all, it was severed about the beginning of the St Louis age.

The coal measures east of the Mississippi river were inaugurated by a slight subsidence beginning perhaps with an ice age.

During the period, the area was subject to frequent oscillations of level, marine conditions prevailing during the subsidence, and land and brackish water when elevations occurred. The area of subsidence, however, did not include any portion of the Appalachian trough, but was terminated along its eastern side by a decided elevation of the old Appalachian valley fold, and a sufficient elevation of the entire Valley trough to bring it permanently above sea level.

West of the Valley fold, and between it and the northeastward continuation of the Sequatchie anticline already mentioned, there was a shallow basin that, at least in Pennsylvania, was occupied by a bay. This bay was in existence during the whole or a portion of the time consumed by the deposition of the Pottsville series, and, as it became filled up with sediment and subsidence continued, gradually merged into the main sea.

Unclassified time scale for eastern North America, and correlation of formations and land intervals in the Mississippian, Appalachian valley, and Atlantic provinces, and their respective basins

The same name in two or more columns indicates direct marine and faunal connection either before or after the birth of the basin under which it is listed. Different names on the same line indicate supposed equivalence in age only.

Names of formations deposited in the Mississippian sea are printed in ordinary type, those laid down in Atlantic waters in *italics*, while names of those deposited when the Mississippian and Atlantic seas were in communication by way of the St Lawrence channel are printed in SMALL CAPITALS, and **heavy face type** is used for formations deposited in Atlantic waters that entered the territory of the Mississippian province by way of the Cumberland basin.

MISSISSIPPIAN PROVINCE	APPALACHIAN PROVINCE					ATLANTIC PROVINCE		GENERALIZED TIME SCALE FOR EASTERN NORTH AMERICA
		APPALACHIAN VALLEY TROUGH						
				LENOIR BASIN				
Mississippian sea	Chazy basin	Levis channel	Middle third	Knoxville trough	Athens trough	Cumberland basin	Skunnemunk basin	
Carbonic	Land	Carbonic	Carbonic	Carbonic	Carbonic	Carbonic	Land	Carbonic
Chemung			Chemung			Chemung	Skunnemunk	Chemung
Portage			Portage			Portage		Portage
Genesee				? Chattanooga	Chattanooga		Bellvale	Genesee
Tully			Hamilton			Hamilton		Tully
Hamilton	Land						Monroe	Hamilton
Marcellus	Deposits not well		Marcellus	Land	Land	Marcellus		Marcellus
Onondaga	known					Land, in south		Onondaga
						Onondaga in north	Land	
Schoharie	Land	Gaspé series. For duration see the generalized time scale				Schoharie		Schoharie
Decewville				Land	Land	Esopus	Esopus	Decewville and Esopus
Upper Oriskany				*Frog mountain*	*Frog mountain*	Upper Oriskany	Oriskanian	Upper Oriskany
Land	Land			Land	Land	*Lower Oriskany*		*Lower Oriskany*
						Kingston		*Kingston*
	St Helens island					*Becraft*	*Helderbergian*	*Becraft*
	Land					*New Scotland*		*New Scotland*
Land						*Coeymans*		*Coeymans*
Manlius in part		Land				*Manlius*		*Manlius*
Land							? Land	*Decker Ferry*
Rondout						Formations at Pinto Md.		Rondout
Salina	Land							Salina
Guelph								Guelph
Lockport						No name. Formations at Cumberland Md.	*Longwood*	Lockport
Rochester			*See* Cumberland basin					Rochester
Clinton	*Anticosti series*							Clinton
Medina						Tuscarora and Juniata	Green Pond	Medina
Oneida								Oneida
Land	Land					Land	Land	Land
Richmond	*Anticosti Hudson river*					Lower Rockwood		Richmond
						Clinch		
Lorraine	Land	Land	Land			Bays	Land	Lorraine
Frankfort	Frankfort	Frankfort	Frankfort	Land	Land			Frankfort
UTICA	UTICA	UTICA	UTICA					UTICA
		Upper Trenton		Sevier	Sevier		Probably land	Upper Trenton
		Normans kill	Trenton			See Middle third for previous deposits		*Normanskill*
Trenton	Trenton	Lower Trenton		Moccasin	Tellico			Lower Trenton
Black river	Black river	Black river	Black river					Black river
Lowville	Lowville	Part of time land	Lowville	Lenoir	Athens			Lowville
Stones river	*Chazy*	*Levis*	Land					Stones river and *Chazy*
BEEKMANTOWN	BEEKMANTOWN	BEEKMANTOWN	BEEKMANTOWN	BEEKMANTOWN	BEEKMANTOWN			BEEKMANTOWN
POTSDAM	POTSDAM	Land	POTSDAM	POTSDAM	POTSDAM			POTSDAM
Lower St Croix	Land	Middle Cambric	Middle Cambric	Middle Cambric	Middle Cambric			Lower St Croix
Land		GEORGIA	GEORGIA	GEORGIA	GEORGIA		GEORGIA	GEORGIA
Land	Land	VERMONT	VERMONT	VERMONT	VERMONT			VERMONT

Summary and general conclusions

Permanence of land masses and of folds of the earth's crust. Our studies tend to the conclusion that the present North American continent was in existence, and practically in full development as land, at the close of Algonkian time and that since that period, the Canadian shield and other smaller Archean land areas have never been wholly submerged. The periodic encroachment of the sea on the Canadian shield attained considerable extent on the north and west and more particularly on the south. The east shore, on the contrary, remained nearly the same till comparatively recent time—probably Postcretaceous.

The present main lines of elevation of the continent were in existence in Algonkian time and have been maintained without serious modification to the present day. Concerning the anticlinal folds that began in Paleozoic and later times, we think that all known evidence bearing on the point goes to prove that, following their inception, they, in common with those of older date, were never changed except 1) to be periodically accentuated, 2) to have their axes migrate slightly landward, like the summit of a wave, in correspondence with effects of active compression and subsequent gravitational adjustments, and 3) to be modified in their relations to the general plan of crustal folding by the development of folds of subsequent origin.

We agree with Walcott's conclusion that in Lower Cambric time the greater part of the interior of the continent was land, and that the first Paleozoic subsidence of the interior and the real birth of the Mississippian sea occurred with what we term the St Croix invasion.

Rhythmic pulsations. There is a rhythmic relation between the successive grand subsidences and emergences of the interior of the continent that we believe should be the basis of a revised classification of the rocks of North America. Such relation was indicated by Amos Eaton and later by Newberry and others. Each system should begin with a subsidence and end with an emergence. While such a classification will be in some respects different from the one now in use, and its adoption therefore

likely to be opposed, we do not doubt that it will prevail in the end because it will have a natural basis.

Depth of Mississippian sea. With the possible exception of the Beekmantown, we fail to see anything even approaching deep sea conditions in any of the sediments of the Mississippian sea. On the contrary, there is abundant evidence that during Paleozoic time the "shift of relative level" of the sea and land was never great outside of the area of the barriers described. Sometimes the sea was so shallow as to form tidal flats, in other cases the land was so near sea level that erosion was practically nil, but in other cases again, the land was high enough to be subject to erosive agencies, the effects of which are now more or less obviously preserved in unconformities of stratification. These unconformities however, are in but few cases so clear that the stratigraphic discordance may be recognized in any given exposure, but their recognition depends in most cases on the absence in a section of a zone or formation observed in other sections. Sometimes, as on the west flank of Cincinnati axis in middle Tennessee, where Upper Devonic or even Lower Carbonic may rest on Middle Trenton, the evidence of unconformity is so slight that without fossils it would scarcely be detected.

Principal submergences and emergences. The first pronounced Paleozoic submergence in North America resulted in what we have called the St Croix invasion. It embraced nearly all of that part of the Algonkian continent lying between the Rocky mountain protaxis and the Appalachian protaxis south of the Canadian shield. This subsidence gave birth to the Mississippian sea, and the movement accentuated a Precambric fold under the Lower Cambric sea extending from Alabama to Gaspé. The northern part of this fold we call the Green mountain barrier, while its southern half is termed the Chilhowee barrier.

The submergence inaugurated by the St Croix invasion culminated in Beekmantown or "Calciferous" time, when more of the continent was under water and the sea probably deeper than at any subsequent period.

The second important movement occurred at the close of the Beekmantown, when the Mississippian sea was restricted to much narrower limits, and possibly almost drained for a short time. With this emergence, which was unusually abrupt and far-reaching in its results, a new fold was developed along the western side of the Appalachian valley extending from Alabama to Newfoundland. This we call the Appalachian valley fold or barrier, its northern end being distinguished as the Quebec barrier and the southern end as the Rome barrier. There is some reason to believe that the Cincinnati axis or parma had its inception in this second movement, though it did not reach the surface of the sea till long after, i. e., about the close of the Black river.

The third pronounced movement occurred at the close of the Ordovicic, when the elevation begun at the close of the Frankfort culminated in the emergence of apparently the whole continent. It gave birth to the Taconic mountains and to a third long Appalachian fold, called the Helderbergian fold or barrier, that excluded the waters of the Mississippian sea from the Cumberland basin, which thereafter was occupied by Atlantic waters till the close of the Esopus.

The next invasion of the Mississippian sea began possibly very soon after the Richmond emergence, bringing in the Medina, Clinton, Niagara and Guelph faunas, the sea apparently spreading a little farther with each succeeding formation. Then a period of emergence set in, continuing in the Mississippian province till Onondaga time, if we disregard the geographically limited Helderbergian invasion of Tennessee and southern Illinois.

The period of submergence following this gradual emergence of the Mississippian province also was one of slow action, beginning with very late Oriskany or Esopus time and continuing apparently into the Lower Carbonic. However, considerable land areas were developed toward the close of the Devonic, so that the rocks of this system also bear evidence of, first a periodically progressing submergence and then an emergence like those more clearly shown for the preceding systems. Similar movements are indicated again for the Lower Carbonic and the Upper Carbonic.

Migrating shore lines. Two excellent examples of a migrating shore line are indicated by 1) the Stones river and 2) the Oriskany and Onondaga invasions. The first, apparently, came in from the south and west and progressed northwardly, reaching the Mohawk and St Lawrence valleys just before the close of the Stones river, the last division of that age being almost uniformly represented there by the Lowville limestone.

The second invasion was very different from that of the Stones river. It came in from both the Atlantic and the southwest, that from the former source advancing rapidly and laying down the coarse deposits of the Oriskany, that from the latter direction progressing apparently more slowly and laying down the limestones of Onondaga age; and, meeting, their respective faunas commingled in the Decewville formation described above.

Effectiveness of folds as barriers to seas. The Green mountains-Chilhowee barrier, the first and oldest fold west of the Appalachian protaxis, was not crossed by the sea from the close of the Beekmantown age to early Siluric time, but through the whole of Siluric and some of Devonic time it was ineffective as a barrier to the Atlantic, which passed over it probably in the region of Maryland. These same waters also crossed the Appalachian valley barrier, but a younger fold (Helderbergian barrier), lying to the west of the other two, still prevented the Atlantic from joining the Mississippian sea throughout the time from Medina well into the Oriskany. The union of the two seas, however, was effected during late Oriskany, in Marcellus and possibly again during a portion of Portage time (Genesee).

The Mississippian sea crossed the Appalachian valley barrier from southwestern Virginia northward to east central New York, excepting the intervals when the north Atlantic by way of the St Lawrence channel crossed it with the Normans kill and Utica deposits and faunas, from Lowville to close of Frankfort time. Previous to this time, and immediately succeeding the formation of the Appalachian fold, the Atlantic invaded the terminal thirds of the Appalachian trough, filling the southern Lenoir basin, which was confined between the effective Rome and Chilhowee barriers, while it occupied two narrow basins in

the north, the Levis channel on the east, the Chazy bay on the west side of the Quebec barrier. Though the Chazy bay extended some distance up the Ottawa valley, there was no communication between the Atlantic and Mississippian seas at this time, a great land area to the west of the bay affording effectual separation.

Communication between the Atlantic and the Mississippian seas occurred at least once besides the Normans kill, Utica, and Devonic connections just mentioned. We refer to the communication that probably began during late Upper Cambric and either continued through or was revived during Beekmantown time.

Basis for more exact faunal and phyletic studies. We have pointed out the Paleozoic periods when the Atlantic and Mississippian seas were separated from each other and also when they were in communication. The relations of the Mississippian sea to the Arctic, northern Pacific and Gulf of Mexico remain in great part yet to be determined. Reliable data are difficult to secure, yet they are not so few as to discourage the hope of ultimate success. When the more essential facts are known, paleontologists will learn to discriminate between the foreign and indigenous elements of our fossil faunas, and incidentally these new facts will throw much light on general geology and organic evolution. They will not then be so likely to arrange heterogenous specific elements as members of one line of descent, nor will they be so eager to identify or throw together species and genera that better and fuller information may prove to represent even different lines of development. The species and genera may have much in common, but the investigator will pause and look carefully into their derivation, both biologic and geographic, before he will feel justified in pronouncing them identical. In short, we shall secure more critical, and therefore more reliable results, and these will bear sound fruit, not only in the domain of pure biology, but also in stratigraphic geology. The farther we progress along the lines indicated, the more exact will our correlations become. Indeed, even extra-continental correlations are not beyond approximate exactitude.

THE INDIGENE AND ALIEN FAUNAS OF THE NEW YORK DEVONIC

BY JOHN M. CLARKE

This paper has been suggested by the important propositions presented in the preceding article which was prepared by Messrs Ulrich and Schuchert at the urgent solicitation of the state paleontologist. The existence of a Paleozoic Appalachian channel parallel to the orographic features of the eastern border is recognized by the writer as an indispensable factor to the proper apprehension of the sequence and geographic relations of the New York faunas. The full value of the considerations set forth by the accomplished authors will be better measured when time has permitted an adjustment of contending evidence by a more complete array of facts. In the following, however, it is in part intended to show, irrespective of the finer analysis of the shore topography, in what manner the Devonic faunas of New York indicate the influence of such Appalachian channel.

By an indigene fauna is meant, in this paper, one which, taking possession of the marine province at an early date, held the ground (subject to variations in its species combination) for a long period, during which may have occurred various minor invasions. This is the correct significance of the term, as every indigene fauna is alien in its inception.

The Appalachian gulf, or marine water of the New York Devonic, had its northern coast line at the opening of this period probably not far south of the present south line of Lake Ontario and the course of the Mohawk river. This statement is made assumptively, as the northern shoreward edges of the sediments of the period have been removed. We may say with some assurance that this continent line was no farther south; it may however have been situated

somewhat more to the north, specially in its westerly extent. In the vicinity of Albany the coast line turned to the south and bent along the present trend of the Appalachians wherever the latter are indicated by topographic features or structural details. At the commencement of Devonic time the Appalachian gulf was a great embayment, opening widely to the northwest and southwest into the Mississippian sea and submerging all the western and central areas of New York and the southeastern area west of the Silurics of Orange and Sullivan counties. The northern coast line spread widely to the northwest through Ontario and Manitoba, the southern extended down the Appalachians through Pennsylvania, Maryland and Virginia. Outside and eastward of the gulf, separated therefrom by a narrow land bar, was, we may confidently believe, in accordance with Messrs Ulrich and Schuchert's deductions, a stretch of water probably of no great width as far as Albany, likewise extending parallel with the Appalachian trend. From the evidences of early Devonic rocks in Massachusetts, New Hampshire and Maine we have reason to believe this area widened irregularly to the Atlantic and passed far beyond the head of the gulf to the northward. Southward down this waterway traveled the congeries of species which in the early Devonic entered New York from a center of prolific development and departure in Gaspé and New Brunswick, and in Siluric times from regions of the east still more remote. This is a condition which had existed long before the Devonic, and the same waters had served as a passage for the migration of species into eastern New York. While the early Devonic saw the continuance of the condition, the later stages of the time witnessed its disruption and discontinuance.

Helderbergian fauna

The earliest of the Devonic faunas of New York is that of the Helderbergian. Geographically the Helderberg sediments, as shown by Ulrich and Schuchert, were laid down east of the land barrier and on the west shore of the Appalachian strait and in our view, also along the widening northern opening of this

passage out into a broad and deeper gulf extending to the northeast continuously or discontinuously to beyond the coast of the maritime provinces. In this deepened head of the gulf the Helderbergian fauna, traveling southward from a long sojourn in inchoative condition in the region of the Gulf of St Lawrence, adding vitality and prolixity on its way (as shown at Dalhousie N. B.), sequestered itself in deepening water and was fruitfully multiplied to its climax. The Helderberg fauna as a whole was thus an invader from the northeast. The narrow bar which separated its first assession from the Appalachian gulf was in a state of degradation so extensive that, at the earliest period of its presence, transgression over this barrier was readily effected, but not a transgression which extended far, as the barrier remained an obstacle to free migration.

The Helderbergian, however, did not gain possession of an extensive area in New York during its earliest manifestations, its species commingled in some measure with the frail Siluric congeries on the ground of central and western New York which had endeavored to reinstate itself with the gradual freshening of the Salina sea, but in later stages of its existence the reintegration of the barrier shut out from the area of the Appalachian gulf all evidence of its final phases (Becraft, Kingston (=Port Ewen) beds). The area of the Helderberg in New York was its fruitful center of dispersion, and thence its travels were southward along the barrier, probably around its southern termination, and from there into the Appalachian gulf in the region of western Tennessee, Illinois and Indian Territory.

Oriskany fauna

From the same direction and along the same thoroughfare came the Oriskany, its center of variation and dispersion unquestionably being in the region of Gaspé bay, where now its species are dispersed through 800 feet of limestone. Leaving behind it species which may have survived in the Gaspé sandstones to a later period of Devonic time, it followed in the train of the Helderberg fauna, manifesting itself most perfectly in the silicious limestones of Columbia and Ulster counties.

Naturally its fauna includes some Helderbergian species, partly picked up in its travels hither from Gaspé and partly found on the ground on its arrival in New York. As pointed out in our previous studies of this fauna, its species trangressed for a very brief period the eastern limits of calcareous deposit and spread themselves westward over the irregular, deeply embayed and probably rocky coast line of central New York and Ontario.

Onondaga fauna

Primarily this fauna is of reef-building corals, and entered the state from the west, where its reefs and attendant organisms attained their greatest prolixity. The lessening and disappearance of the coral facies eastward and the final loss of the limestone deposit evince this derivation. Any submarine barrier in the east however was so deeply submerged at this epoch as not to interfere with the deposition of chert-bearing limestone in Columbia county east of the Hudson river. The east presents in the arenaceous beds of the Cauda-galli and Schoharie grit a facies which is not elsewhere seen. In clastic character, there is excellent reason for associating these beds directly with the deposition of Oriskany sediments as a closing stage thereof, and indeed several elements of the striking Schoharie fauna indicate derived relations to the Oriskany. This might be predicated of the trilobites specially, of the brachiopods and lamellibranchs in part, but not of the most conspicuous element of the fauna, the cephalopods. For the origin of the latter we have yet to search; they may have entered New York from the west with the fauna of the limestone and have wandered into the shallow waters where Schoharie sediment was depositing; they may have, on the other hand, come in from some source, northeast or southeast, as yet unknown to us, and hence be related ancestrally to similar forms of the overlying Onondaga limestone. Present evidence seems to favor the former conclusion without disparagement to the genetic relations of these cephalopods to those of the Onondaga. It seems justifiable however to assert that the fauna of the Onondaga period as a whole, with its noteworthy coral, trilo-

bite, cephalopod and gastropod facies unequally developed locally, is a complex congeries, largely from the western reaches of the Appalachian gulf, but freely inoculated with elements genetically from the northeast. The latter may have come in directly, geographically and genetically, through the Oriskany province of eastern New York or indirectly into the western limestones, after migration from New York southward to the end of the barrier and thence into the heart of the gulf. The latter seems specially probable of the gastropod element.

Marcellus fauna

As the Onondaga limestone fauna came in from the west, so it withdrew westward. In the latest stages of its immigration it brought in the cephalopod Agoniatites expansus; but when this species had penetrated to eastern New York this ground had been occupied for some time by shallowed and foul waters, wherein were depositing the black muds of the Marcellus shale with its accompanying singular fauna. Early Marcellus deposits in eastern New York were thus contemporaneous with late Onondaga deposits in western New York. This being true, the Marcellus fauna entered the New York area of the gulf from the southeast or from the direction of the eastern shore. The effect of the putative eastern barrier and its accompanying northeast channel is now no longer perceptible save as we ascribe to the submergence of the latter in part the befouling of the waters.

Fauna of the Agoniatites limestone

It has just been stated that Agoniatites expansus came into New York from the west in the closing stage of Onondaga time. The limestone to which it appertains forms a very distinct band in the Marcellus section of eastern and central New York, and associated with it is a small and exclusive congeries of species, with some which belong to the fauna of the shales. So far as concerns the peculiar species which characterize the fauna, they have probably all been derived from the same direction at the same time as Agon. expansus.

Hamilton fauna

Fauna of the Stafford limestone

This is another and higher limestone bank in the Marcellus shales, but extends no farther east than Ontario county, while the Agoniatites limestone goes no farther west as a limestone than the same meridian. The Stafford limestone contains the earliest extensive representation of the normal fauna of the Hamilton stage. This is not actually the earliest appearance of the fauna, for a calcareous layer just at the base of the Marcellus shales in western New York also carries Hamilton species commingled with others surviving from the Onondaga fauna, but the Stafford affords a pure Hamilton fauna. The incursion of this congeries in this manner is very significant; the limestone and its contents are lost east of Ontario county, but from there to the western limit of the state its course is unbroken. Thus it clearly indicates that the Hamilton fauna, both in this prenuncial expression and in its normal return, after its retreat had been covered by a considerable period of deposition in the gradually clearing Marcellus waters, entered the state from the west; whether from the northwest, through the opening of the shore line up through Manitoba and thence westward through Siberia to the Ural Devonic sea, or up from the south, skirting the Devonic shore line of eastern South America, where it arrived by shore from Africa and its center of dispersion in Belgium and the Eifel or, again, along the assumed north Atlantic land line, can not yet be determined.

Tully fauna

This fauna is essentially constituted of derivatives from the Hamilton with the addition of two brachiopods of world-wide distribution, Hypothyris cuboides and Schizophoria tulliensis (cf. S. striatula Schloth.). The former is an excellent index fossil of the lowest Upper Devonic, the latter a belated newcomer of Middle Devonic habit. So far as the special expression of the fauna imparted by these two species is concerned, it does not elsewhere manifest itself in

eastern America; but there is abundant evidence to show that the species themselves have come into the gulf by the northwest passage.

Naples fauna

This is the fauna of the Styliola limestone embedded in the black Genesee shales and of the Portage beds of western New York, ranging up to and beyond the summit of the original Portage sandstones. The fauna is distinctly an invader from the northwest.[1] It has almost naught in common with the Hamilton fauna which preceded it on the ground, but is a congeries of oceanic organisms which together constitute the zone of M a n t i c o c e r a s i n t u m e s c e n s, well marked in many parts of the world but nowhere with a more prolific fauna than here. Eastward of Cayuga lake its integrity is lost by mergence with the contemporaneous Ithaca fauna. The migration path of this pelagic fauna has been traced toward the northwest through Manitoba into Siberia, thence through Russia into Westphalia. Where it was originally autochthonal is not certain; perhaps Westphalia was its home, but in New York, where its fauna became extensive, it was alien and short-lived.

Ithaca fauna

Contemporaneously with the Naples fauna in western New York the Ithaca fauna held the field in central New York approximately, except in its latest stages, from Cayuga lake on the west to the Chenango valley on the east.

The Ithaca fauna is genetically sequential to the fauna of the Hamilton epoch. Its species are at first identical with those; then variations superinduced on these specific types manifest themselves, and in the event the fauna in its totality is clearly distinct from its ancestor. Hemmed in on the east by the barrier which made the Oneonta waters a lagoon, and on the west by the invading Naples fauna, it found favorable opportunity for multiplication and variation on ancestral

---

[1]The authors of the preceding paper regard the Naples invasion as from the Atlantic. This is an assumption unsupported by any evidence known to the writer.

ground. It is indigene, for its ancestry had taken and lost possessions early in Marcellus time by invasions from the west, retaken and held possession from the beginning of Hamilton time. It is to be noted that through a part of the extent of the Ithaca sediments there is nothing separating them from the Hamilton beds below, the Tully limestone and Genesee shale feathering west of the Chenango valley.

Oneonta fauna

Contemporaneous with the latter part of Ithaca sedimentation was the sparse fauna of the Oneonta sandstones. These we believe to have been deposited in a narrow coastal lagoon, and its few characteristic organisms, Amnigenia catskillensis, Estheria membranacea, are of fresh-water habit. The latter occurs in the Old Red lakes of northern Scotland, species of the former in nonmarine deposits of Ireland and the Eifel. We are left to surmise that these species found their way into New York by fresh or brackish water passage from the Old Red lakes of Nova Scotia (Arisaig) and Quebec (Gaspé).

The Catskill. The Catskill represents a continuation of Oneonta sedimentation; that is, deposition in a deep embayment but with freer access to the open waters of the gulf, thus constituting a long and narrow estuary extending far southward parallel to Appalachian trend. It may well be compared to the conditions now existing in the Lake of Stennis in the Orkney mainland as described by Hugh Miller, in which the upper reaches are fresh and bear a fresh or depauperated brackish water fauna while the lower parts are salt and marine. We know that this condition (including the deposits of the Oneonta) prevailed in eastern New York from the close of the Hamilton through Portage and Chemung time and in southern New York continued into the early Carbonic.

Chemung fauna

The main body of the Chemung fauna is the direct derivative along the long line of descent from the Hamilton through the

Ithaca fauna. As a benthonic littoral congeries, chiefly of lamellibranchs and brachiopods, it has acquired variation with age, and, on the removal of the obstructions to migration which prevailed in Ithaca time, it disseminated itself eastward to the Catskill embayment, probably over it at times and westward beyond the limits of the state. It also spread over the heart of the gulf and along its southward shore. From this, its home province and center of dispersion, departed, or to it were added, certain widespread species, such as Spirifer disjunctus and the glass sponges. It is however as a whole the last expression of the single New York fauna of Devonic time which may be properly characterized as indigene.

EXPLANATION OF PLATES

Plate 3

Thamnocladus clarkei White

Page 596

FIG.

1 Greater portion of a large frond partly buried in the matrix. The segments are somewhat macerated and show the effect of current dragging. Natural size. Chemung, at East Windsor N. Y. New York state museum.

CHEMUNG ALGA

G. S. Barkentin del. Phil. Ast, lith.

Plate 4

Thamnocladus clarkei White

Page 596

FIG.

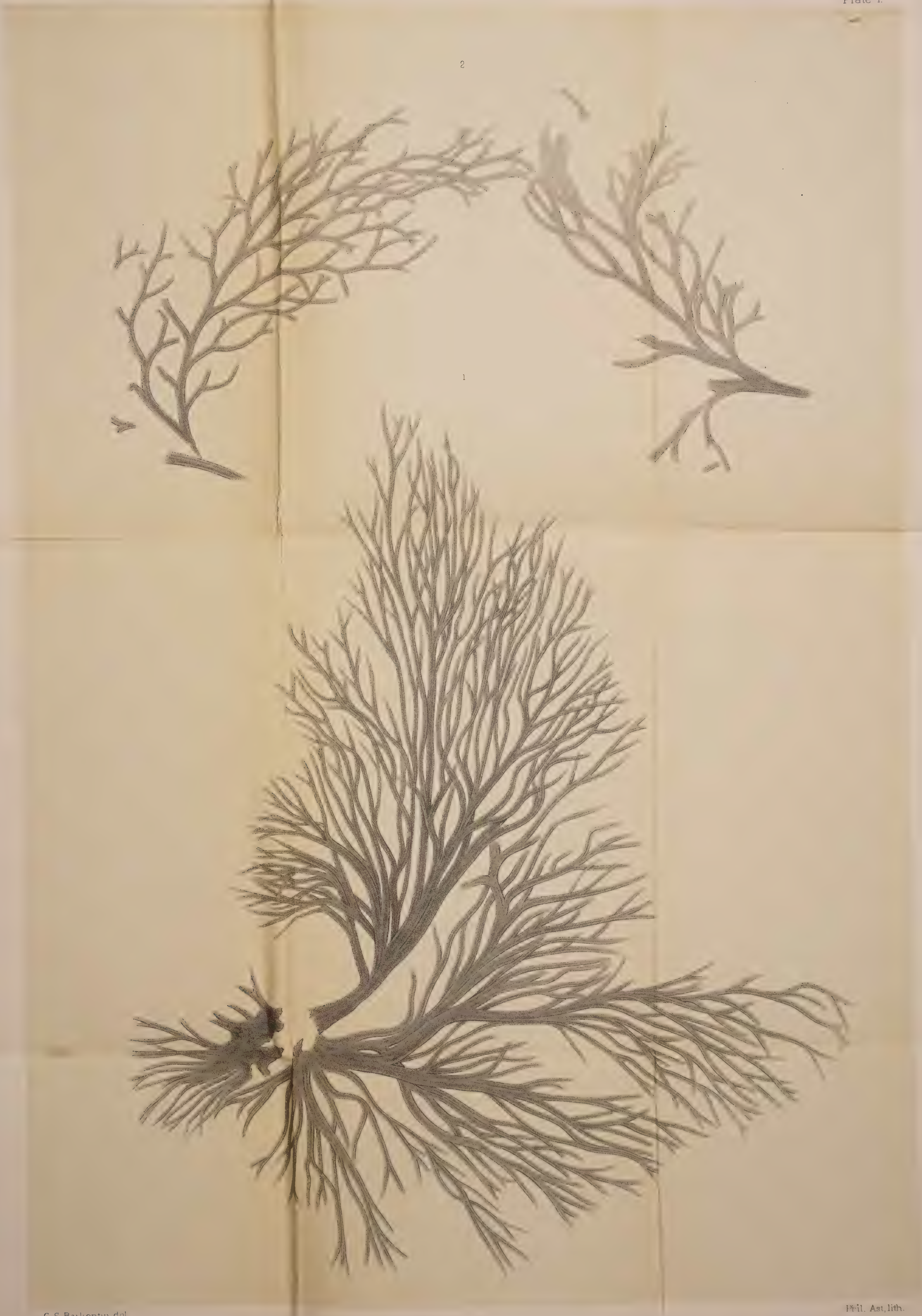
1 Portions of several segments, probably belonging to the same frond or the same tuft. The different portions lie at different levels in the bed, the larger ones passing out at the back side of the slab. Natural size.

Same slab as pl. 3.

2 Isolated portions of two segments showing more distinctly the mode of division, the aspect of the terminal portions and the lamina. Natural size.

Catskill at Factoryville, Wyoming co. Pa. No. 25072, Lacoe collection, United States national museum.

CHEMUNG ALGA



G S Barkentin del

Phil. Ast, lith.

PLATE 5

Eunoa accola Clarke

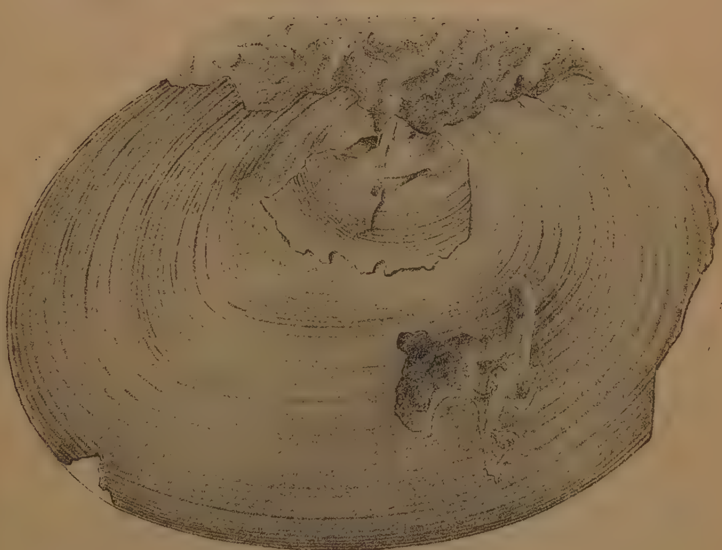
p. 607

(*See* pl. 6)

FIG.

1 A large brachial valve incomplete at the posterior edge. Beekmantown graptolite shales. Deep kill, Rensselaer co., N. Y.

EUNOA.



G S. Barkentin. del. J. B. Lyon Co. State Printer Phil. Ast, lith.

PLATE 6

Eunoa accola Clarke

p. 607

(*See* pl. 5)

FIG.

1 Two valves overlapping and exposing the pedicle notch with clearly defined margins. The posterior margin of the brachial valve is here again not clearly defined.

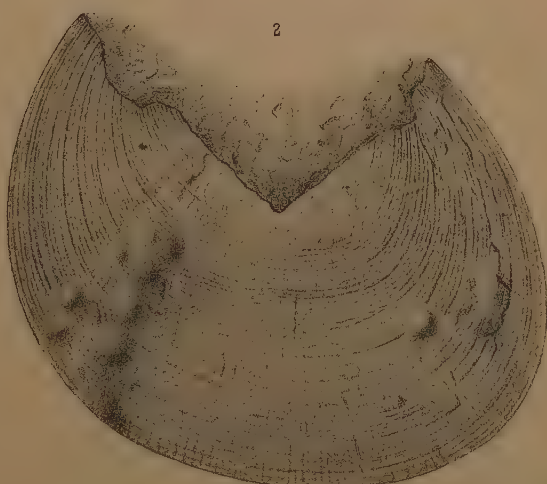
2 A pedicle valve with the margins of the pedicle slit approximately entire for most of their extent, though pressed apart.

Beekmantown graptolite shales. Deep kill, Rensselaer, co. N. Y.

EUNOA.

1

2



G. S. Barkentin, del. J. B. Lyon Co., State Printer. Phil. Ast, lith.

PLATE 7

Orbiculoidea ? magnifica Clarke

p. 615

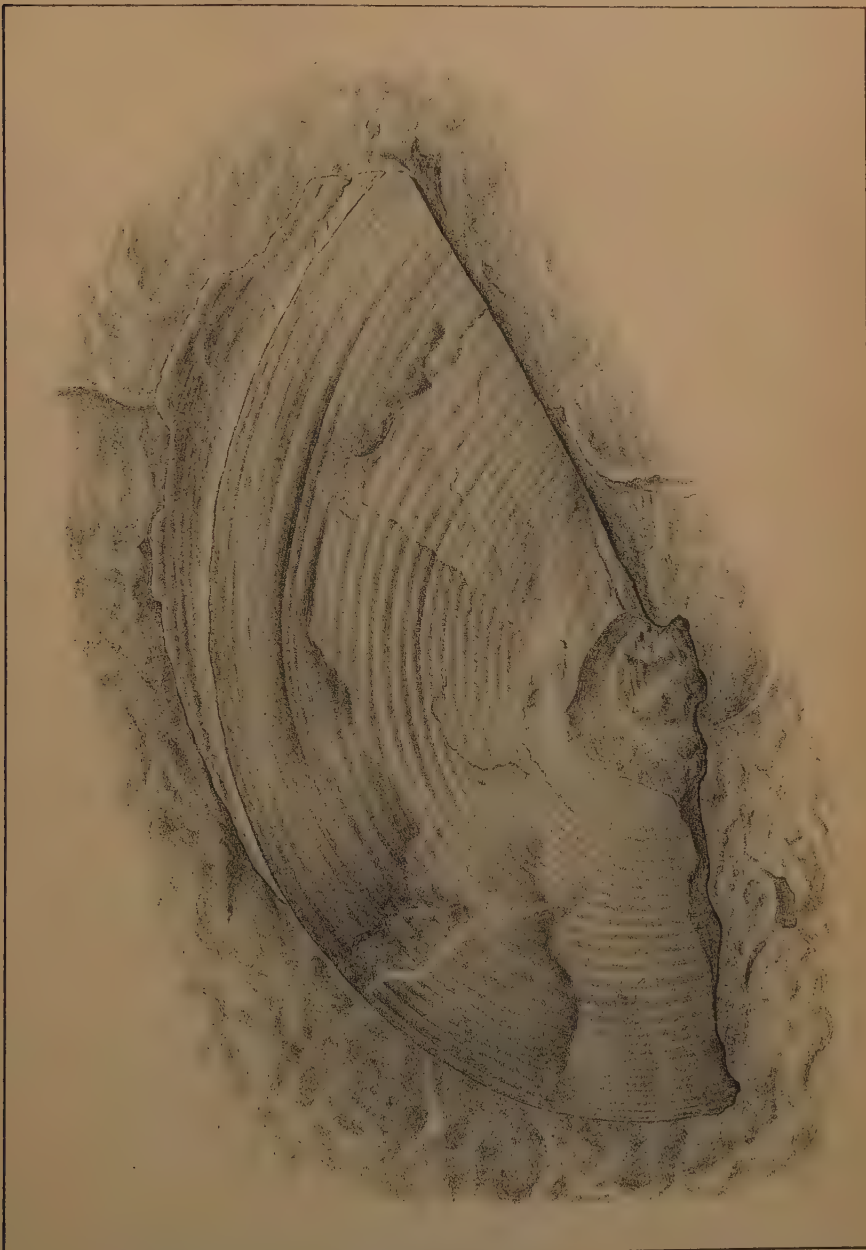
(*See* pl. 8)

FIG.

1 The half of an infolded pedicle valve showing the pedicle opening extending for the full radius of the shell. The margin of the infolded portion of the valve is visible at the periphery of the shield.

Portage beds. Tannery gully, Naples N. Y.; at an horizon just above the final appearance of the Naples fauna.

ORBICULOIDEA.



G S. Barkentin del. J. B. Lyon Co., State Printer. Phil. Ast, lith.

PLATE 8

Orbiculoidea ? magnifica Clarke

p. 615

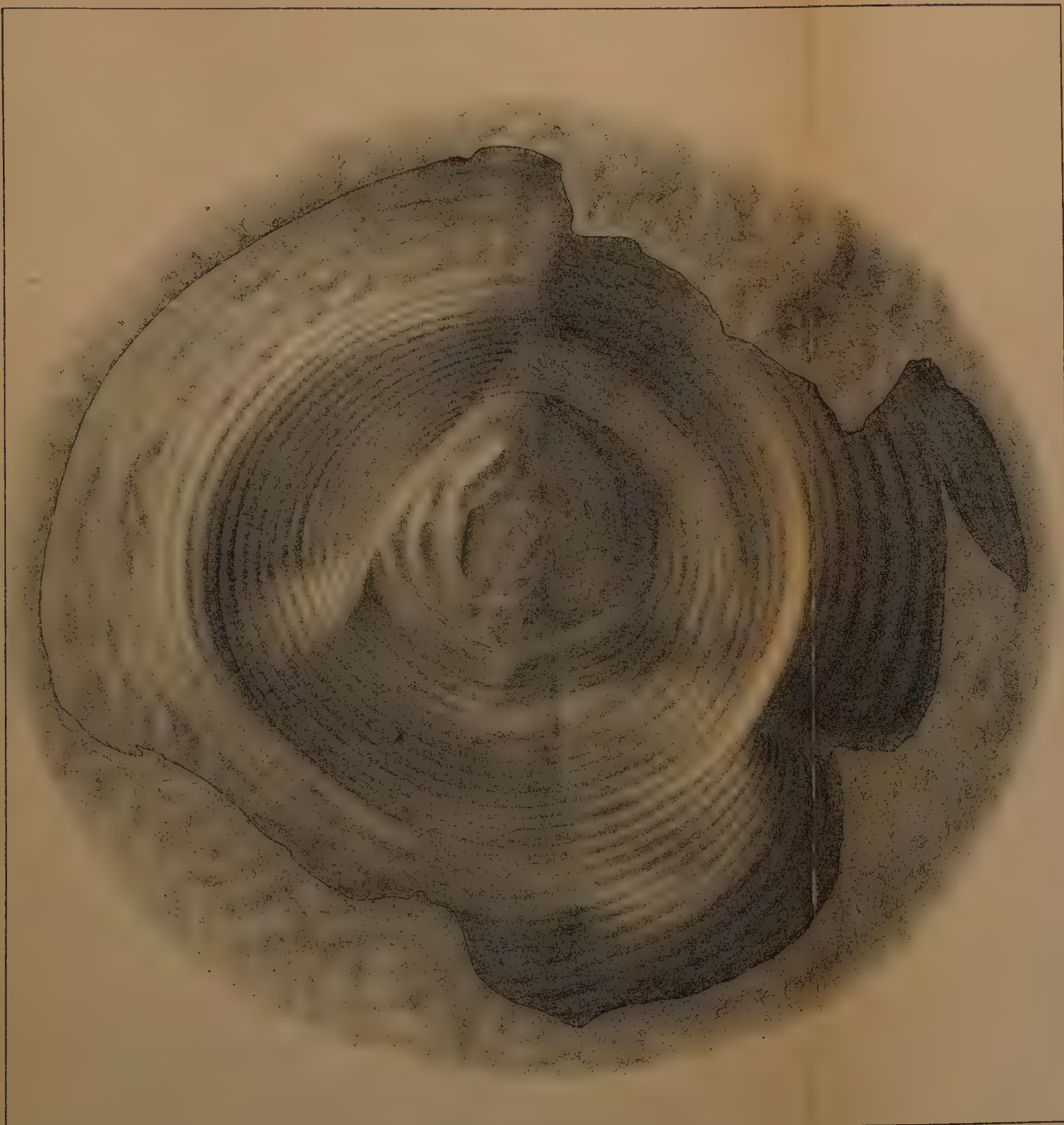
(*See* pl. 7)

FIG.

1 A large depressed conical shield believed to represent the brachial valve of this organism. Drawn from a plaster cast.

Ithaca beds. Truxton N. Y.

ORBICULOIDEA.



G. S. Barkentin. del. J. B. Lyon Co. State Printer. Phil. Ast, lith.

INDEX

Page numbers referring to descriptions of fossils are printed in black face type. The superior figures tell the exact place on the page in ninths; e. g. 623^3 means page 623, beginning in the third ninth of the page, i. e. about one third of the way down.

(Pages 695-96 were bulletin cover pages)

Published monthly by the
University of the State of New York

BULLETIN 263 | AUGUST 1902

New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 53

ENTOMOLOGY 14

17th Report of the State Entomologist ON INJURIOUS AND OTHER INSECTS OF THE STATE OF NEW YORK

1901

New York State Museum

Frederick J. H. Merrill Director
Ephraim Porter Felt State entomologist

Bulletin 53

17TH REPORT OF THE STATE ENTOMOLOGIST

1901

To the Regents of the University of the State of New York

I have the honor of presenting herewith my report on the injurious and other insects of the state of New York for the year ending Oct. 15, 1901.

General entomologic features. The forest tent-caterpillar, Clisiocampa disstria Hübn., as was predicted last year, has, generally speaking, not been nearly so injurious the last season, though in places here and there in the state, it has inflicted considerable damage. Its abundance in orchards adjacent to woods badly infested the previous year was a somewhat characteristic feature of the attack this season. The common apple-tree tent-caterpillar, Clisiocampa americana Fabr., has also been abundant in different sections of the state, but it has not been specially injurious as a rule. The white marked tussock moth, Notolophus leucostigma Abb. & Sm., has been quite harmful to the shade trees of Buffalo. The destructive work of the elm leaf beetle, Galerucella luteola Müll., has been continued in the Hudson river valley, and in its northern part this insect has succeeded in extending its range to a number of villages previously infested with very few or none of these pests. The fall web worm, Hyphantria cunea Drury, has been exceedingly abundant in portions of the southern part of the valley and near the western end of Long Island. The depredations of the Hessian fly, Cecidomyia

destructor Say, were so general and so severe as to inflict enormous damages, they having been estimated by competent parties as high as $3,000,000. A very serious matter has been the discovery that the notorious gipsy moth, Porthetria dispar Linn., has become well established in the city of Providence R. I. Investigations made during the summer show that the pest already occupies a considerable area in and about that city. While this spread has not been directly toward New York state, it may well be regarded as a warning of what may occur within a few years, and residents of the state are advised to keep a sharp lookout for the advent of this very destructive insect.

Office work. There has been no relaxation in the pressure of office work, and, though there has been an apparent decrease in the amount of correspondence, all of the office staff have been obliged to work overtime in order to meet the demands of the situation. The determination of scale insects for the state department of agriculture still makes considerable inroads on our time. Most of this important and very difficult work has fallen on my first assistant, Miss Boynton. On the request of the commissioner of agriculture, made necessary by the position of the state entomologist of Virginia, who refused to accept any certificate unless it was vouched for by an official entomologist, a general statement was issued approving the work of his inspectors. The time of the office force has been occupied to a considerable extent by the reading of proof and verification incident to the carrying through the press of two very important bulletins soon to be issued, one on the important scale insects of the state and the other on aquatic insects of the Adirondack region. A number of excellent lantern slides have been purchased, and some made from original photographs. These form a nucleus of what will soon become an excellent collection for use in illustrated lectures. The new cards for recording accessions to the entomologic collections have proved very satisfactory, resulting in a great saving of time. 954 letters, 295 postals and 693 packages were sent through the mails during the year.

There has been an unavoidable break in the office caused by the resignation of my first assistant, Mr C. S. Banks, who severed his connection with the office July 15, a particularly unfortunate time, since it is the season when insect activities are at their hight. Miss Margaret F. Boynton was promoted to the position of first assistant, and Mr C. M. Walker, who has been an advanced student in entomology for nearly two years under Prof. C. H. Fernald of the Massachusetts agricultural college and who was the special assistant in the preparation of the collection for exhibition at the Pan-American exposition, was appointed second assistant.

Special investigations. Three lines of work mentioned in my previous report have been prosecuted during the past season.

1 The series of experiments with insecticides for the control of the San José scale have been carried on in the same orchard as last year, and the results obtained in 1900 have been largely confirmed. Fuller details of this work will be found on subsequent pages.

2 The study of forest and shade tree insects has been continued, and many of the observations of previous years have been prepared for publication, and those of this season will be put in a similar condition as soon as possible.

3 The special study of aquatic insects, begun in 1900 has also been continued. It is noticed in the following paragraph.

Entomologic field station. The work commenced at Saranac Inn in 1900 was continued at Ithaca N. Y. in cooperation with the Cornell university authorities. Dr James G. Needham of Lake Forest university, Lake Forest Ill. was in charge of the work, as last year. It was largely supplemental to the studies of the previous season, and Dr Needham's report will therefore include a rather full account of the damsel flies, Odonata-Zygoptera, and of the fish food material collected by him at Saranac Inn. A family of small flies (Chironomidae), very important so far as fish food is concerned, has received special study by Mr O. A. Johannsen, an advanced student at Cornell university, and his account will also be included in this report.

Publications. The principal publications of the entomologist, to the number of 62, are listed under the usual heading. The most important of these is the 16th report. Owing to the delay incident to printing, three very important publications have not appeared during the past year, though they are practically ready to be issued. They are: Museum bulletin 46, *Scale insects of importance and list of the species in New York state*, Museum bulletin 47, *Aquatic insects in the Adirondacks* (Dr Needham's report for 1900), and the special paper treating of insects injurious to elm trees. The last is to appear in the 5th report of the fisheries, game and forest commissioners of New York state. These three publications are admirably illustrated by a series of colored plates.

Extension work. Considerable of the time of the entomologist and his former first assistant, Mr C. S. Banks, was occupied by farmers institutes. They covered a period of 23 working days, during which lectures were delivered at the following 14 places: Preston Hollow, Durham, Hensonville, Lexington, Fleischmanns, Halcottsville, Grand Gorge, Walton, Gilbertsville, South New Berlin, New Berlin, Russia, Newport and Frankfort. An important paper was read by the entomologist before the Massachusetts fruit growers association at a meeting held last March at Worcester Mass., and several addresses have also been given by him before various scientific and horticultural organizations.

Collection of insects. The additions to the state collection of insects have been very great. They may be estimated at approximately 16,000 pinned, labeled specimens, besides a great many in alcohol. A special effort has been made to secure desirable biologic material. My former assistant, Mr Banks, and my present assistant, Miss Boynton, have spent a great deal of time during the past year in going over the collection and classifying the insects more thoroughly. Most of the state collection has now been referred to families, and considerable work has been done on beetles (Coleoptera), the scale insects (Coccidae), and the grasshoppers (Orthoptera). The work on the two latter

orders was done entirely by Miss Boynton. Most of that on the Coleoptera was done by Mr Banks, though Mr Walker has given some time to this order in the past few months. An immense amount of work is still necessary before the collection will be in a thoroughly satisfactory condition.

The office has been very fortunate in retaining the entomologic library and collection of the late Dr J. A. Lintner. These collections are not only of great value in a scientific way but they are almost indispensable aids in conducting the work of the department. It is very gratifying that they should be placed where they will receive the best of care, and surely no place is quite so appropriate as the institution where Dr Lintner did most of his scientific work.

Pan-American collection. The preparation of an exhibit for the Pan-American exposition at Buffalo involved much work on the part of the regular office force in addition to that performed by a special assistant, Mr C. M. Walker, who was engaged for three months. It was felt that, since an exhibit was to be prepared, it should be put in first class shape, and so far as possible this was done. One gold and three silver medals were awarded the exhibit. A brief account of this collection together with a catalogue is appended to this report.

New quarters. The removal of the office from the old quarters in the capitol to Geological and agricultural hall has been a great advantage, since it gave not only much needed space but also essential facilities. The floor space of the general office and the amount of shelving have been much increased by the change, but there is still none too much room. The admirably equipped dark room in the general office supplies a much needed want, as it permits the photographing of insects and their work in a minimum amount of time. The space outside of the general office affords an excellent opportunity for the display of insects and their work in a place readily accessible to the public. Several special collections have already been prepared and placed on exhibition, and it is proposed to give considerable prominence in the display collection to the injurious and bene-

ficial forms. The large one now at the Pan-American exposition will also be placed on exhibition as soon as it is returned.

Voluntary observers. Most of the persons cooperating with the office in 1899 and 1900 in this capacity have continued to render substantial aid this season. Their number has naturally decreased somewhat, and, on account of the pressure of work in early spring, due to the preparation of the exhibit at Buffalo, there was little opportunity to strengthen their ranks. Many valuable observations were made, and summaries of the reports will be found on p. 776–800.

Acknowledgments. The entomologist is under obligations to other workers along the same lines. To Dr L. O. Howard, chief of the division of entomology of the United States department of agriculture, and his staff, special acknowledgments are due for the determination of a great many insects and for promptly placing information at my disposal. Prof. J. H. Comstock of Cornell university deserves special mention for so kindly placing the facilities of his department at the service of the entomologic field station, and for giving the work such hearty support.

It is a pleasure to acknowledge the continued support and encouragement given by the regents during the past year. The work has necessarily been somewhat hampered by the moving into new quarters and by unforeseen changes in the staff, but the outlook for the future is most auspicious.

Respectfully submitted

EPHRAIM PORTER FELT

State entomologist

Office of the state entomologist

Albany 15 Oct. 1901

INJURIOUS INSECTS

Cecidomyia destructor Say

HESSIAN FLY

Ord. *Diptera;* Fam. *Cecidomyiidae*

This species was first observed in this country in New York and its common name was bestowed in the belief that it came to us in packing or straw shipped to the Hessian soldiers then stationed on Long Island. The probabilities tend in that direction though absolute proof may always be wanting. This pest attracted the attention of entomologists in the early part of the last century on account of its serious injuries, as it gradually spread over the country. Dr Asa Fitch, entomologist of the New York state agricultural society was one of the first to give a detailed account of it and much that he published can not be bettered in this later day. His account is now almost inaccessible to the general public and though the pest has been treated in some detail by later writers, particularly by Prof. Webster and Prof. Osborn, there is no complete recent account of it as it occurs in New York. A very good general account of the insect in the United States is given by Prof. Osborn in Bulletin 16, new series, division of entomology, United States department of agriculture.

Early injuries in New York by the Hessian fly. This summary account of the depredations of the pest is taken largely from the quite full treatise on it given by Dr Packard in the 3d report of the United States entomological commission.

The Hessian fly first became a serious pest in 1779 at which time and for several succeeding years wheat was severely injured or wholly destroyed by it in Kings and Richmond counties. In 1786 and 1787, its ravages again attracted considerable attention in this state, the crop of eastern Long Island having been almost universally destroyed. In 1803 very severe losses were caused by its operations in Saratoga and Washington counties and on two or three occasions in earlier years many of the fields in Saratoga county were entirely destroyed. Again in 1844 losses occasioned by it on Long Island and at Rochester

were very severe. Throughout the state of New York it was exceedingly destructive in 1846. In the western section it was estimated to have caused a loss of not less than 500,000 bushels. It was also very injurious in some counties in New York and in Ohio in 1849. It was exceedingly destructive about Syracuse in 1876, whole fields and parts of others turning yellow and showing the ravages of the fly to a greater extent than had ever been witnessed, and in 1877 and 1878 white wheats were severely damaged, the presence of the Hessian fly in Cayuga, Seneca, Tompkins and Yates counties being specifically recorded. There was some injury in Tioga county in 1881 and very slight damage was reported in 1882 from Columbia, Genesee, Herkimer, Monroe, Niagara, Yates and Wyoming counties, it being more serious in the latter. Dr Lintner, in his 5th report, p.263, states that this insect caused more injury than usual in western New York in 1884.

Recent injuries in western New York. The following records were taken largely from reports of voluntary observers.

1899. The Hessian fly has done much damage in the wheat fields in and about East Amherst, Erie co. In my own fields one fifth of the wheat is down. This was sown on Sep. 9, 1899. Some fields that were sown in August are from one half to nine tenths down. All wheat fields in this vicinity are damaged more or less. Even those that were sown the latter part of September or in early October are infested to some extent. (John U. Metz)

The Hessian fly is doing considerable damage in and about Belle Isle, Onondaga co. (Mrs. A. M. Armstrong)

The Hessian fly has seriously injured early sown wheat all through Seneca county. Some pieces are very seriously damaged while others are comparatively free from the pest. It is estimated that about one fourth of the crop has been lost through the attacks of this insect. (J. F. Hunt, Kendaia)

I noticed very bad work indeed in this section from the Hessian fly. A great amount of wheat is down. Perhaps one third of the straw is lodged and the damage will be one fourth of the entire yield. (C. H. Stuart, Newark, Wayne co.)

1900. The Hessian fly is in the vicinity of East Amherst in great numbers and the white wheat throughout this section is nearly all down flat. One field of 8 acres in this vicinity is almost totally destroyed. It was sown August 27. (John U. Metz, Erie co.)

The wheat in the vicinity of Warner, Onondaga co. was damaged more than last season. Fully one third of it lodged and the injury is more general than last year. I have found the flies in late sown wheat. One piece sown September 10 was very thoroughly infested, not a single plant being free from the pest. (Mrs A. M. A. Jackson)

The Hessian fly has done a great deal of damage to some pieces in this section of the country. (J. F. Hunt, Kendaia, Seneca co.)

The Hessian fly has been very bad in some wheat, some pieces being so very severely injured that they have not been harvested. (C. E. Chapman, Peruville, Tompkins co.)

The Hessian fly has been working very badly indeed in early sown wheat. The later sowings are not nearly so badly infested. Perhaps one fourth of the entire crop has been destroyed. (C. H. Stuart, Newark, Wayne co.)

1901. Damage from Hessian fly work is very evident in several pieces of wheat examined. Probably 10% of the stalks have lodged as a result of the work of this fly. (M. H. Beckwith, Elmira, Chemung co.)

Mr M. F. Adams of Buffalo, after making an examination of a number of fields in the vicinity of that city finds that the damage as a rule runs from 6% to 8%. Very little wheat, however, is grown in the immediate vicinity of Buffalo and it is not surprising that the few fields sown should escape serious injury.

The Hessian fly is present in overwhelming abundance. Many fields of white wheat are not worth cutting. There seems to be no difference between the early and late sown wheat. One field was sown September 15, another September 21 and another September 29 and yet 90% of each one of these fields is on the ground. Red Russian and red Mediterranean wheats seem to

be exempt thus far from attack. (J. U. Metz, East Amherst, Erie co.)

J. F. Rose of South Byron reports as follows: A large acreage of what early promised to be good wheat will not be worth cutting as a result of Hessian fly attack. A few farmers are plowing up their wheat but as the wet weather has been favorable for a good catch of clover, many will not plow it up as they are anxious to save the seeding. Very little or no white wheat will be harvested in this vicinity. Some farmers I saw yesterday had not been in their wheat fields for a few days and the grain had gone to the bad very rapidly since they saw it. I visited and examined wheat fields in three towns today and I have heard some bad reports from other neighboring towns. Several fields of red wheat have been examined and they are not badly infested as yet. 90%, however, of the wheat in this section is white, a variety known as no. 6. It has been exclusively grown for some years, as the quality is good and it is a fine yielder. The red wheat is known as no. 8. As regards proximity of other fields, there is so much grown that all fields are comparatively close. Probably there is no field that is a half mile from another and most of them are much nearer or within a quarter mile of one another. The prospect early was very good for yields of 20 to 35 bushels an acre in all fields, as there was little winter injury. A field near here belonging to G. G. Chick was not sown till the first week in October and it looked well much later in May than early sown fields, but today Mr Chick tells me that there will be no wheat. This wheat is no. 6. One farmer reports that the fly can now be found in barley. Regarding the farmers from whom I have reports, it is quite certain that some of them have estimated their yield of wheat too high. The few stalks standing are about as thick as hoop poles and when pulled up it is found that they are infested with the fly to some extent. The damage will hardly exceed 5% in the fields of red wheat. The following are reports from fields of wheat in this vicinity:

William Caswell of South Byron sowed 10 acres of white wheat September 3 and today he thought that he might get 10% of the crop. 10 acres of white wheat were sown by him on the 16th and the grain is no better than in the preceding field. 10 acres of red wheat were sown by him September 13 and this variety was not damaged to exceed 5%.

Clifford Davey of Leroy township sowed 12 acres of white wheat between September 12 and 15 and now he is plowing the ground up for beans. 12 acres of the same variety were sown by him between September 18 and 20 and this field has not been so very badly injured. Probably about one fourth of the grain is down.

Frank C. Walker of Stafford township has 40 acres of white wheat which he began sowing September 12 and finished on the 20th. Mr Walker does not expect to more than get his seed back. The grain sown first is a little worse than later plantings but there is not much difference. The first of May there was an excellent prospect of getting 25 bushels an acre. The last crop on these fields ranged from 25 to 40 bushels an acre.

Lucien Campbell of Stafford township sowed 12 acres of white wheat between September 7 and 9. Today he estimates that 15% of the grain is still standing.

James Berlin of Stafford township sowed 32 acres of white wheat September 15, the grain following barley and oats. He now estimates that he may get 5 bushels an acre. 7 acres were sown by him October 1. This was on ground used for growing corn the previous year and it is 60 rods from any other wheat. This field is no better than those sown early in the season though two weeks ago it looked as though it might produce 30 bushels an acre.

Henry Bucklin of Stafford township sowed 11 acres of red wheat between September 15 and 20 and it appears to be but little damaged up to date.

John Walsikoski of South Byron has 24 acres of white wheat sown between September 10 and 12 but he will not get his seed back.

William Scoins of Stafford township has 4 acres of white wheat sown September 7 or 8 and he will not get his seed back. 16 acres sown September 20 is no better than his earlier sown pieces, though it did not show injury as early in the spring.

Charles Buckland of South Byron has 15 acres of red wheat sown September 5 and 75% to 80% of it is apparently all right.

George Kelly of South Byron has 8 acres of red wheat sown September 1 and 80% of it is free from injury. Another field of 42 acres of red wheat sown between September 3 and 8 looks well and bids fair to yield 25 to 30 bushels an acre.

William Cork of South Byron sowed 8 acres of red wheat September 9 and 75% of it is all right. In sowing this field, the drill skipped two strips across the field and when the wheat came up the omission was seen and white wheat was sown in its place. The Hessian flies have destroyed all of this white wheat.

John Berlin of Elba township sowed 54 acres of red wheat between September 10 and 13 and he estimates that his crop will average more than 20 bushels an acre. There is very little evidence of insect injury.

The Hessian fly is also in rye, timothy and barley in this vicinity. A perfectly reliable farmer tells me that he has found as many as 50 larvae of the fly in one stalk of barley. One of our large farmers in South Byron is now cutting his barley and curing it for hay, it is so badly infested with Hessian fly. I went yesterday to see some wheat in Leroy township that is locally known as golden chaff or Clauson's golden chaff. This is a white wheat and has been but little troubled with the Hessian fly. It is no more injured than the red wheat, known as no. 8. Many farmers will sow this kind and the red wheat but if none of the flies' favorite no. 6 be sown, Mr Rose is inclined to think that these more or less resistant varieties will suffer another year.

R. L. Darrison of Lockport, Niagara co. investigated the injuries by Hessian fly in his vicinity and the reports received by him do not vary very much from those made by other parties.

The fields of white wheat, even those sown quite late in the season suffered severely while those of red wheat, whether sown early or late, escaped with comparatively little injury. White wheat as a rule suffered anywhere from 30% to 80% or more loss while rarely more than 20% of the red wheat was injured. This report covers fields representing over 200 acres. He also states that severe injuries were reported to him from Orleans and Seneca counties.

Mrs A. M. Armstrong, Belle Isle, Onondaga co. states that the Hessian fly has been quite abundant in that section. She writes: "My father, who has had an opportunity to watch a number of fields in a general way is of the opinion that late sowing is not a preventive measure and as late sown wheat does not do as well as that sown earlier, he has for years followed the practice of sowing his about September 10. He has now 25 acres sown September 25 in which the fly worked last fall, causing it to stool considerably but not many of the plants were killed while in fields of late sown grain many of the infested plants died. Specially was this true in fields where commercial fertilizers were not used in the drills. My father saw one field where the farmer was careless and let his fertilizer box become empty half way across the field. No phosphate was applied on the last trip across the field or on the headlands and in these places the fly worked very badly indeed. In some unfertilized rows there were places of a foot or more where the wheat was entirely killed. Mediterranean wheat appears to be relatively free from the pest."

Virgil Bogue of Albion, Orleans co. reports that wheat is in bad shape from the Hessian fly.

Miss Harriet M. Smith of North Hector, Schuyler co. reports comparatively little injury in her immediate vicinity, though some damage is said to have occurred at Trumansburg, Tomkins co.

J. F. Hunt, Kendaia, Seneca co. states that some pieces of wheat have been one third destroyed by Hessian fly while in others there is very little injury. He fails to find much evi-

dence in favor of the late sowing of wheat. The only pieces that were exempt were some of those sown so late that it would not be advisable to follow such an example. One field of 30 acres sown the last week in October was free from the fly. The barley crop was completely destroyed in Seneca county.

C. E. Chapman of Peruville, Tompkins co. reports that the Hessian fly is in nearly every stalk. Many fields have been nearly ruined and there will not be half a crop. The most of the sowings were made between August 25 and September 20.

C. H. Stuart, Newark, reports that in a seed bed where they have several varieties of wheat all were badly infested with the fly except one row of Dawson's golden chaff, not one straw of which is down. It is most remarkable as the rest is very bad. This check row was sowed by hand, the rest by machine, and was put in 1 inch deeper. All were sown at the same time.

W. H. Roper, Wyoming, Wyoming co. reports on a number of fields to the effect that from one fourth to one half of the wheat had become lodged by June 10 and on June 19 he reports that many fields in that vicinity will not be harvested on account of the poor crop. 4 acres of Genesee giant sown by him September 19 was not infested with the fly. It has a very coarse straw and stands up in good shape. His no. 6, sown the next day, was about half ruined as nearly as could be estimated.

The above records show very plainly indeed that the destructive work of the Hessian fly has been increasing and gradually extending during the last three years. For example, in 1899 injuries were reported only from the counties of Onondaga, Seneca and Wayne; in 1900 accounts of injuries were received in addition from Erie and Tompkins counties; and in 1901 serious complaints came from Chemung, Erie, Genesee, Niagara, Onondaga, Orleans, Schuyler, Seneca, Tompkins, Wayne and Wyoming counties. In each case the reports were accompanied by the statement that the injuries had been much greater than in preceding years. In Genesee county in particular, through the energetic action of J. F. Rose, exceptionally full data was

received and there is little reason for believing, after making allowance for the relative amounts of wheat grown in the various counties, that the conditions reported in this county were essentially different from those in some of the others. It has been estimated by good authorities that half the normal crop of New York was destroyed by the Hessian fly in 1901, entailing a loss of about $3,000,000.

An investigation in the fall of 1901 showed that in regions where the Hessian fly had been injurious, mostly red wheat (largely no. 8 in some sections, at least) had been sown and that very little or no Hessian fly could be found in such pieces. A few of the pests were found in volunteer white wheat (no. 6) but no field of this was examined as none were in the vicinity of the places visited.

Description of various stages. The adult fly is rarely observed by wheat growers. It is a small, nearly black, dark winged

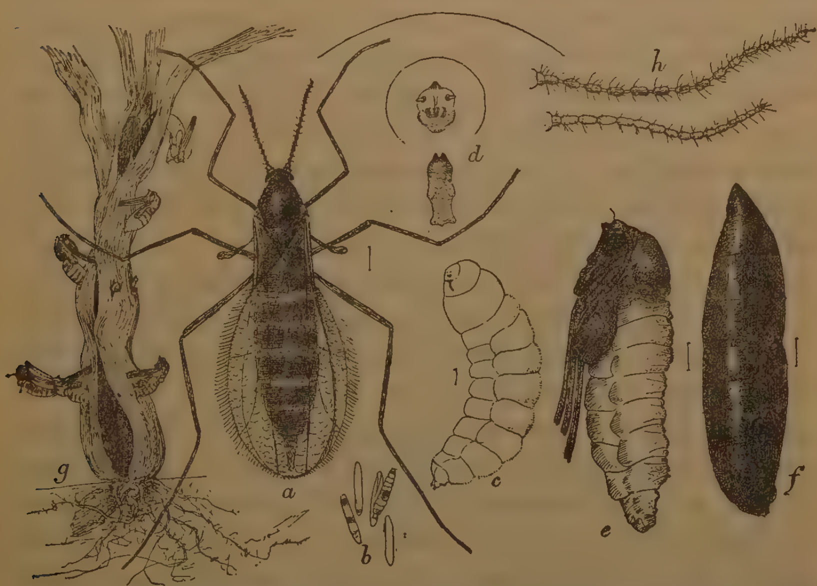


Fig. 1 Hessian fly: *a* female; *b* flaxseeds or puparia; *c* larva or maggot; *d* head and breast bone of same; *e* pupa removed from puparium; *f* puparium or flaxseed; *g* infested wheat stem; *h* male and female antennae; *b* and *g* about twice natural size, all others much more enlarged (after Marlett, U. S. dep't agric. Farm bul. 132)

midge about $\frac{3}{32}$ inch in length and possesses very long, slender legs. There are a number of closely related flies which have a similar appearance but ordinarily if one about this size and having the general appearance represented in fig. 1*a* is found on

young plants in wheat fields, it is very likely to be this notorious pest.

The puparium or "flaxseed" stage is so well known that a description is hardly necessary. The "flaxseeds" are about $\frac{1}{8}$ inch long, of light brown color and occur near the base of the plants. One very much enlarged is represented at *f* in fig. 1.

The slender, delicate, greenish white maggots are also somewhat familiar to the wheat grower and a detailed description of them in this connection is hardly necessary. The full grown larva is about $\frac{1}{8}$ inch long and it is usually found in the field between the sheath and the stem of the young plants.

The eggs have been sufficiently characterized in a following paragraph treating of their deposition.

Food plants. The food plants of the Hessian fly are of considerable importance because if it is able to subsist on a number of grasses and grains its control is manifestly much more difficult. The Hessian fly was early recognized as a pest of wheat, rye and barley, and despite the fact that records are occasionally met with of its occurrence in timothy and other grasses and grains, the weight of evidence seems to indicate that it does not live to any extent at least on anything but the above crops. It is possible that at exceedingly rare intervals, comparatively speaking, a few may mature on timothy, but in some instances at least related species have been confounded with it.

Life history. Normally there are two generations in this latitude though there may be several supplementary ones. The adult fly may deposit from 100 to 150 eggs, according to Marchal, placing them between the ridges on the upper surface of the blades of young wheat. Individuals of the spring brood occasionally thrust their eggs beneath the sheaths of the lower leaves. The process of oviposition has been carefully described by Mr Herrick as follows:

While depositing her eggs the insect stands with her head toward the point or extremity of the leaf, and at various distances between the point where the leaf joins and surrounds the stalk. The number found on a single leaf varies from a single egg up to 30 or even more. The egg is about $\frac{1}{50}$ inch long, cylindric, rounded at the ends, glossy and translucent, of a pale red color,

becoming in a few hours irregularly spotted with deeper red. Between its exclusion and its hatching these red spots are continually changing in number, size and position and sometimes nearly all disappear. A little while before hatching two lateral rows of opaque white spots, about 10 in number, can be seen in each egg.

The flies may occur any time after the wheat is up and before killing frosts, and possibly, as pointed out by Dr S. A. Forbes, *between* killing frosts. The eggs hatch in about four days and the maggots or larvae then make their way down the leaf to the base of the sheath. These soft maggots do not burrow, but lie between the sheath and the stem and absorb their nourishment from the adjacent soft tissues, which gradually become depressed and give way as the little insect develops. The maggots are usually found in the fall close to the roots of winter wheat and at or beneath the surface of the soil, while the spring larvae are more common about the second or third joint of the plants. The larval transformations occupy about 20 days but their duration is considerably affected by weather conditions. The duration of the pupal stage is very variable and is much affected by climatic conditions. Cold or heat and dryness tend to lengthen and heat and moisture to shorten the duration of the different stages, specially the pupal. The winter is passed by this insect in the "flaxseed" or pupal stage. The spring brood of flies emerge in April or May and in turn lay eggs on the more luxuriant leaves and another life cycle may be completed in about 30 days.

Number of generations. The short time necessary to complete the life cycle permits a number of broods in one season and apparently there are as many generations as weather and food conditions will permit, and we may expect constant breeding of this insect during the growing season if continued damp weather enables wheat, barley and rye to grow luxuriantly throughout that period. During midsummer as a rule the fly, if it appears at all, will find only a little volunteer wheat in fit condition for it to live on, but this was very different with barley in 1901. The spring brood had passed through its transformations and the continued moist weather brought out the flies in hosts. Eggs were laid in large numbers in the barley, specially in that which

was sown late, and in early July many fields in Genesee county were badly infested. The pests were near the ground in the latest sown barley and in that early sown, they occurred from 10 to 12 inches from the ground, showing at least, that the insect breeds by preference in the soft growth and inferentially that it thrives only indifferently in the older, harder growth. This relation between the rank succulent growth of the grain and injury by the Hessian fly was further shown on one hilly patch of wheat. There was considerable grain on the gravelly, comparatively dry knolls while in the more moist, probably poorly drained gullies the stalks of wheat were very scattered. Here seems to be a possible reason why a variety of wheat may be comparatively "fly proof" in one section and not in another, since its apparent resistance may depend very largely on the relative hardness or maturity of the stalk at the time the flies appear and deposit eggs and this might easily vary in widely separated sections during the same season. Another generation might easily have developed, so far as time is concerned, between the middle or the latter part of July, at which date the above mentioned brood attained its maturity, and the period when the normal fall brood appears, which is usually before September 20 in New York. The above shows that four generations and possibly more may develop in a season, but it should be distinctly understood that, as a rule, only two full broods are developed, and that the intermediate summer generations are usually very limited and that their development is very dependent on weather and crop conditions.

Emergence and flight. This is an exceedingly important matter, because on its correct understanding rests one of the most successful methods of preventing injury by this pest. This, like the development of the summer generations, is dependent on weather conditions. The following rules will aid in understanding the situation:

1 The flies may remain an indefinite period in the "flaxseed" or pupal stage during dry weather.

2 "Flaxseeds" or pupae are very likely to develop flies in large numbers during a period of damp, warm weather.

3 Adults are killed by heavy frosts but this is not true of larvae and "flaxseeds" or pupae and hence flies may appear and deposit eggs *between* killing frosts.

4 Under certain conditions some of these insects may spend nearly a year in the "flaxseed" stage.

The above rules show that egg-depositing flies may appear at any time during the growing season, providing weather conditions are favorable, though naturally we would expect them to appear in great numbers only at the first favorable period after a large brood had attained the "flaxseed" or pupal stage. Thus, as our springs are usually warm and moist, this means that ordinarily most of the "flaxseeds" will develop flies in the latter part of April or early May. Then there must be a sufficient period for the completion of a life cycle before another brood of flies can appear and if at that time and for a considerable period thereafter the weather be dry and hot, comparatively few or no flies will appear till conditions change and consequently we can not tell just when flies will appear again.

We do know, however, that early sown winter wheat is very apt to become badly infested in the fall while late sown wheat frequently escapes. In the first instance the young wheat is up and receives a deposition of eggs before or *between* killing frosts, while in the other case it escapes. Weather conditions must always be considered in sowing winter wheat. The general rule for the safe sowing of winter wheat may be stated as follows:

Moist warm weather in early fall will permit the safe sowing of wheat at a relatively early date, but when the early fall is dry, delay sowing till the latest possible date. The normal or average date when wheat can be sown in New York without danger of its becoming infested with the Hessian fly is about September 20.

Effects of continued dryness and moisture. Following is an interesting record by Dr Riley:

It has long been known that the Hessian fly flourishes best when the chinch bug flourishes least; in other words, that wet weather favors it. The prejudicial effect of drouth has not been hitherto observed, that we are aware of, but it was very noticeable in parts of Ohio, where the puparia literally dried up. Our attention was first called to the general death of the

insect in the "flaxseed" state by E. W. Claypole of Yellow Springs O. and our observations subsequently confirmed his experience. The intense heat had not only dessicated the Cecidomyia but what is still more remarkable, in most cases the parasites also.

On the other hand wet weather favors their development and under the influence of frequent showers the flies have been known to issue in large numbers from their "flaxseed" cases in early summer. This was very nicely illustrated last July in case of the barley attack. The continued rains in the spring induced the flies to complete their transformations early and July 10 a number of places were seen where the spring brood of the fly had completed its transformations and departed. This was further confirmed by finding several large fields of barley sown about May 15, badly infested with larvae and young puparia of this insect. The barley attack was confined largely to the upper, softer nodes and in at least one large field the infestation was very thorough. Every stalk was infested with a few of the pests and eight plants taken at random from this field contained from 19 to 54 individuals, most of them being in the larval stage. This serious infestation is very interesting when compared with the following record of the weather in two localities in that section of the state. The table given below is compiled from the records of the New York state weather bureau and shows the total precipitation in each of the growing months and the number of rainy days.

TABLE OF PRECIPITATION

Alden, Erie co.

Year	Month	Total precip. in in.	No. rainy days
1900	Aug.	2.48	7
	Sep.	3.26	7
	Oct.	3.18	7
	Nov.	8.42	16
1901	Mar.	3.09	12
	Ap.	4.34	11
	May	4.49	18
	June	1.49	7

Elba, Genesee co.

Year	Month	Total precip. in in.	No. rainy days
1900	Aug.	2.39	11
	Sep.	2.69	7
	Oct.	3.59	8
	Nov.	3.99	21
1901	Mar.		
	Ap.	4.25	10
	May	5.13	19
	June	3.38	10

It will be seen from the above table that last May was very wet, rain falling 18 and 19 days respectively in the two localities. It is no wonder that the spring generation of the fly completed its transformations and that the adults were ready to oviposit and infest the late sown barley.

Signs of infestation. The first indication of attack is found in the darker color of the leaves and a tendency among the young plants to stool freely. The broader lower leaves and the absence of a central shoot, it having been killed, are also noticeable in infested fields. As the attack advances the infested plants turn yellow or brown and die and the maggots may be found at the base of the leaves near the ground. The spring brood attacks tillers or laterals which were unharmed in the autumn, dwarfing and weakening the stems so that the grain usually lodges before ripening and can not be harvested well.

Rule for determining time for sowing winter wheat. This has been the subject of considerable study by Prof. Webster of Ohio and Dr Hopkins of West Virginia. The latter, in Bulletin 67 of the West Virginia agricultural experiment station, has given in considerable detail much data bearing on this subject and in that bulletin he elaborates a very interesting rule for determining this date in various sections of the country. His results are not only based on considerable scientific research, but they have been confirmed by practical experience. Dr Hopkins finds: 1) That under similar conditions of land surface, other than altitude, there is a normal rate of difference of time in the periodical phenomena of plants and animals for all differences in latitude and altitude. 2) That under normal conditions the rate of average variation for the beginning or ending of any phenomenon is not far from one day for every fourth of a degree of latitude, or for every 100 ft of elevation. Using this rule and taking as a base the time, September 25, determined by Prof. Webster through observation as the date when the Hessian fly normally disappears from fields about Columbus O. in latitude 40° and with an altitude of 800 ft, it will be found that in Genesee county, latitude 43°, the normal period when wheat can be sown without injury by the Hessian fly is September 21. This calculation is for sea level and the date may be pushed forward

approximately one day for each 100 feet of elevation. The method of reaching this conclusion is as follows: the 3° difference in latitude between the two places gives an allowance of 12 days, that is four for each degree of latitude, and as Genesee county is farther north, the 12 days may be subtracted from the date given for Columbus, but before subtracting this, the date for Columbus must be brought down to a sea level calculation, and as that date is September 25 at 800 feet above sea level, the safe date must be eight days later, or approximately one day later for each 100 feet less in elevation. This brings the safe date at Columbus O., were it at sea level, at October 3, and bringing this date forward 12 days, the allowance made for the 3° difference in latitude, we have the normal date for Genesee county in localities at sea level. This date, September 21, may then be advanced one day for each 100 ft elevation above sea level.

At first sight this rule may appear a little cumbersome, but it is really a very simple one and it certainly deserves a trial by every farmer troubled with the Hessian fly. If it accomplishes nothing more, it gives a basis on which to begin experiments, and we are therefore able to approximately figure the safe date for any locality and then this should be checked up by past experiences or put to the test of future use. The farther north the location and the higher the elevation, the earlier may the wheat be sown with safety.

Parasites. The parasites of the Hessian fly are very important, since were it not for them it is extremely probable that it would be much more destructive than it is. The easiest way to determine the proportionate number of parasites in any one field is to take infested stalks and breed the adult insects from them. A net-covered jelly tumbler or fruit jar, taking care to avoid close covers and resulting molds, will answer very well as a breeding cage. Later in the season, after the parasites have emerged under natural conditions, an examination of "flaxseeds" in the field will give some idea of the relative number which have been killed by these tiny friends of man, since each having a cir-

cular hole in the side has produced a parasite and not a fly. Sometimes fully nine tenths of the Hessian flies are destroyed by parasites and occasionally entomologists have experienced difficulty in breeding any adult flies from infested wheat stems because the parasites were so numerous.

Fig. 2 Merisus destructor (after Riley)

The above notes give some idea of the importance of these little creatures. One of the most efficient of these parasites is known as Merisus destructor Say, a minute four winged fly which is represented in the accompanying illustration. It occurs not only

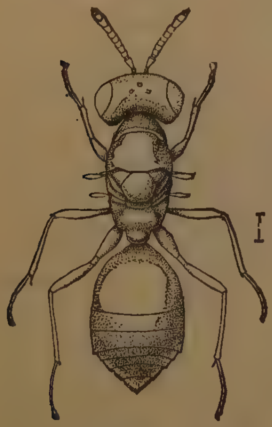


Fig. 3 Boeotomus subapterus (after Riley)

Fig. 4 Platygaster herrickii Pack. (after Riley)

throughout the American territory affected by the Hessian fly but it is known in England and Europe.

Another parasite which ranks next in economic importance to the preceding is known as Boeotomus subapterus. It is frequently wingless as seen in fig. 3. The proportion of winged to wingless individuals is said to vary at different seasons of the year. In Missouri this species has been bred from infested wheat stalks more commonly than the preceding.

Platygaster herrickii Pack., represented in the accompanying figure, is another common parasite of this grain pest.

This little parasite has been credited with puncturing the Hessian fly eggs and laying its own therein to hatch later and consume the larva. This was considered a very improbable method of attack, as most true egg parasites complete their life cycle within the egg itself though the observations of Marchal on Trichasis have shown the probability of such a mode in this species.

Entedon epigonus Walker. This species was introduced into this country in 1891 through the efforts of Dr C. V. Riley who received parasitized pupae from Fred Enoch of England. These were distributed to Prof. Forbes of Illinois, Prof. Cook, then of Michigan, and Prof. Webster, then of Indiana. It is impossible to state even at this date how much benefit may ultimately result from the introduction of this para-

Fig. 5 Entedon epigonus Walk. (after Howard, Insect life, 7:356, 1895)

site, but Mr Marlatt, writing of the Hessian fly in 1901, states that considerable good may be expected from it. It had become established in the vicinity of Washington D. C. and presumably in Illinois, but whether it will continue to hold its own and prove an efficient aid in the control of this serious pest remains to be seen.

Two other primary parasites of the Hessian fly are known in America. They are Pteromalus pallipes Forbes and Eupelmus allynii French.

Preventive and remedial measures. *Late sowing.* One of the most important preventive measures is to delay sowing till after the adult flies have deposited their quota of eggs and perished. In New York this means delaying sowing as a rule till September 20 or a little later. A preceding paragraph gives more specific directions for the determination of the date when wheat may be safely sown in different latitudes and at varying altitudes. The difference in latitude in New York is relatively slight but altitude has considerable influence on the period when wheat may be sown with safety. The experiences of 1900 and 1901 have demonstrated anew the destructive powers of this pest and as many of the holdings in western New York are exceedingly small and the fields of wheat so near one another that it is very easy for the flies to make their way from one to the other, the delaying in the date of sowing is of itself not sufficient to guaranty immunity from the ravages of this insect.

Resistant varieties. There is probably no such thing as absolutely fly proof wheat but experience has shown that the varieties known as no. 8, Dawson's golden chaff, White chaff, Mediterranean, red Russian, prosperity and democrat have withstood the attack of the Hessian fly very successfully in western New York, even when the beardless, weak-stemmed white wheat known as no. 6 was very seriously injured and sometimes totally destroyed. Some of the varieties badly affected by the fly are better yielders than the above but the only safe way is to sow one which is able to resist attack to a considerable extent. It is very remarkable that while Dawson's golden chaff was so free from injury in the Empire state, it sustained much harm last spring in Canada, its native home.

Good culture. Thorough culture counts for very much when trying to grow a good crop of wheat. The field should be thoroughly prepared and the land gotten into excellent condition before it is considered fit for the crop. An endeavor should be made to get a growth of firm straw and to produce plants vigorous enough so that if attacked they will tiller

abundantly and thus avoid a serious decrease in yield. A badly drained soil, where conditions favor a moist growth of succulent straw, appears to be quite favorable to the fly and in some such places the injury was much more manifest than on higher well drained land. Prof. Webster of Ohio, who has studied this insect for over 15 years, believes that four fifths of Hessian fly injury can be prevented by a better system of agriculture.

Trap strips. This device has long been recommended by entomologists and was earnestly advocated by Dr Fitch but there has been considerable difficulty in getting farmers to take up the idea and go to the trouble of preparing a little ground, sowing it early and then turning it under soon after the flies have deposited their eggs. Many wheat growers prefer to wait and take their chances on the crop not being seriously injured by the fly. S. W. Wadhams of Garland N. Y. made a test of this plan with most excellent results. Aug. 25, 1900 he sowed two widths of the drill round a 20 acre field and then sowed the remainder on September 27 and 28 and just before the last sowing came through the ground, his decoy strip was plowed under, put in condition and resown. At the time of plowing he found that practically every leaf and stalk of the wheat was completely covered with the eggs of the fly, so that the strip turned brown and myriads of the flies swarmed up in front and over the horses as they walked over it. The result was that in 1901 he harvested 21½ bushels of no. 6 wheat an acre. This yield was secured when other fields of no. 6 wheat were so badly injured as to produce from three fourths of a crop to almost nothing. Mr Wadhams sowed another trap strip Aug. 20, 1901 and on September 14 he found that the young wheat plants were being rapidly covered with eggs of the Hessian fly, and he now suggests that the trap or decoy strips be plowed under about nightfall or in the cool of early evening, at a time when the few remaining flies, if any be alive, would naturally be resting on the wheat plants, and the chance of covering them deeply would therefore be immensely increased. Agricultural practice in western New York does not always admit of the

trap strip round the sides of a field to be sown with wheat and fortunately this is not necessary because, from what we know of the habits of the flies, it is very likely that they would be attracted to a patch of wheat sown some little distance, a half mile or more from the field which it was proposed to put into wheat. It would be better undoubtedly to have a trap strip beside the field, but if that is impossible, much may be gained by sowing a small patch of wheat at some little distance and turning it under as proposed above.

Burning stubble and chaff. This has been recommended by a number of writers but in western New York at least the common practice of sowing to grass with wheat, prohibits the burning of the stubble. This objection would not hold in regard to burning the chaff from the threshing machines and this might well be done in case the wheat is at all infested by the Hessian fly.

Plowing under stubble. This is also impractical in cases where grass follows wheat but in other instances it would certainly do no harm if the stubble is at all infested, and it is advised where no additional labor or expense be entailed.

Rotation of crops. The judicious rotation of crops will undoubtedly do considerable toward reducing the ravages of this insect, particularly if care is taken to have the wheat fields of successive years at some distance from each other.

Destruction of volunteer wheat. The Hessian fly breeds in volunteer wheat, and wherever possible without incurring undue labor and expense such wheat should be destroyed or plowed under before it can produce the adult flies.

BIBLIOGRAPHY

The following citations include most of the more important early notices of this insect and nearly all of those relating to the recent injuries by it in New York.

1792 **Havens, J. N.** Observations on the Hessian fly. Soc. in N. Y. for promoting agric., arts and mfgr's. Trans. pt. 1, p. 89-107 (observations on origin, ravages, life history and remedies).

1817 **Say, Thomas.** Original description and notes on life history. Acad. nat. sci. Jour. 1:45-48; *same republished in* Le Conte. Say's Complete writings. 1883. 2:4-6.

1818 **Say, Thomas.** Hessian fly, grain moth, cut worm. Phila. soc. prom. agric. Mem. 4:236-37 (oviposition, burning stubble recommended).

1826 **Hunter, David.** Bd agric. state N. Y. Mem. 3:55-56 (time of appearance of flies).

1841 **Herrick, E. C.** Observations on Hessian fly. Am. jour. arts and sci. 41:153-58.

1843 **Morris, H. M.** Observations on the development of the Hessian fly. Acad. nat. sci. Proc. 1:66-68 (observations).

1843 —— On the Cecidomyia destructor or Hessian fly. Am. phil. soc. Trans. 8:49-51 (observations on life history).

1844 **Gaylord, Willis.** N. Y. state agric. soc. Trans. 3:141-43 (brief account).

1844 **Herrick, E. C.** Patent office rep't. Agriculture, p. 161-67 (brief general account).

1845 **Fitch, Asa.** Insects injurious to vegetation no. 2. Am. quar. jour. agric. and sci. 1:255-69 (generic characters of Cecidomyia and mention of C. destructor).

1846 —— Insects injurious to vegetation no. 4. Am. quar. jour. agric. and sci. 4:244-64 (early history and synonymy).

1846 **Morris, H. M.** Amer. jour. of agric. and sci. 5:206-8 (controversy on habits of Hessian fly).

1847 **Fitch, Asa.** Hessian fly. N. Y. state agric. soc. Trans. 6:316-73 (summary account); (same, separate date 1847, p. 3-60).

1847 —— Insects injurious to vegetation no. 5. Am. quar. jour. agric. and sci. 5:1-27 (life history, habits, parasites and remedies).

1854 **Glover, Townsend.** Insects injurious and beneficial to vegetation. Patent office rep't. Agriculture, p. 72-74 (brief account).

1858 **Johnson, B. P.** Wheat midge, Hessian fly, etc. N. Y. state agric. soc. Trans. 18:287-303 (records of injuries in New York).

1862 **Fitch, Asa.** N. Y. state agric. soc. Trans. 21:819-30 (general account of the insect in the U. S.); *same in* Noxious and other insects of New York. 7th rep't. 1862. p. 133-44.

1862 **Harris, T. W.** Insects injurious to vegetation, p. 568-87 (general notice).

1863 **Fitch, Asa.** N. Y. state agric. soc. Trans. 22:685-86 (historical notes on the early history of the Hessian fly in this country); *same in* Noxious and other insects of New York. 8th rep't. 1863. p. 203-4.

1866 **Walsh, B. D.** Hessian fly. Prac. ent. 2:7 (late sowing of more value than trap strips).

1866 —— Joint worm. Prac. ent. 1:37-38 (characteristics of Hessian fly); A new humbug, p. 108-10 (exposes fraudulent claims for controlling this insect).

1872 **Lintner, J. A.** Hessian fly. Country gentleman, June 13, 37:376 (brief note identifying Hessian fly).

1878 —— Hessian fly. Country gentleman, Jan. 24, 43:55 (brief general account).

1880 **Hagen, H. A.** Hessian fly not imported from Europe. Can. ent. 12: 197-207 (discussion of subject).

1880 **Hagen, H. A.** Probable parthenogenesis of Cecidomyia destructor. N. Am. ent. 1:65-66 (notes on development of unfertilized eggs).

1880 **Lintner, J. A.** Hessian fly. Country gentleman, July 8, 45:439 (brief general account).

1880 **Packard, A. S.** Hessian fly. Am. ent. 3: 118-21 (preliminary notes).

1880 **Packard, A. S.** Hessian fly. U. S. ent. com. Bul. 4, p. 1-43 (detailed account); Hessian fly. Am. nat. 14: 586 (notes on work done in controlling pest).

1880 **Riley, C. V.** Probable parthenogenesis in the Hessian fly. Am. ent. 3: 127 (parthenogenesis and relative abundance of Hessian fly).

1881 **Riley, C. V.** Hessian fly. Am. nat. 15: 750 (Hessian fly abundant in central and southern Illinois and in Missouri); Effect of drought on Hessian fly, p. 916 (records drying up of puparia).

1881 **Riley, C. V.** Hessian fly. Am. nat. 15: 750 (record of injury in Illinois and Missouri).

1882 **Lintner, J. A.** Hessian fly in Ohio. Country gentleman, July 20, 47:567 (brief note identifying Hessian fly).

1883 **Hagen, H. A.** Hessian fly not imported from Europe. U. S. ent. com. 3d rep't. App. p. 43-49 (résumé of evidence).

1883 **Koppen, F. T.** Account of the Hessian fly. U. S. ent. com. 3d rep't. 1883. App. p. 41-42.

1883 **Packard, A. S.** Hessian fly—its ravages, habits and the means of preventing its increase. U. S. ent. com. 3d rep't. 1883. p. 198-248 (detailed account).

1885 **Forbes, S. A.** Ill. state ent. 14th rep't, p. 38-50 (notes on life history and parasites).

1885 **Hagen, H. A.** Further material concerning the Hessian fly. Can. ent. 17: 81-93 (records concerning early occurrence of pest in America); On the Hessian fly in Italy, p. 129-31 (notes).

1885 **Webster, F. M.** Purdue univ. Sch. of agric. Bul. 1, p. 1-10 (brief general notice).

1886 **Riley, C. V.** On the parasites of the Hessian fly. U. S. nat. mus. Proc. 1885. 8: 413-22 (critical, descriptive and biologic accounts).

1887 **Forbes, S. A.** Ill. state ent. Bul. 3, p. 45-61 (observations on life history).

1888 **Forbes, S. A.** New parasite of the Hessian fly. Psyche, 5:39-40 (describes Platygaster hiemalis).

1888 **McMillan, Conway.** Neb. agric. exp. sta. Bul. v. 1, no. 2, p. 17-23 (brief general notice).

1888 **Riley, C. V.** Hessian fly an imported insect. Can. ent. 20: 121-27 (discussion of evidence relating to the introduction of this pest); Insects confounded with the Hessian fly prior to the revolution. Insect life, 1:86 (states that species Chlorops or Meromyza has been con-

fused with the Hessian fly); Remarks on the Hessian fly, p. 107-8 (discussion of evidence relating to introduction of this pest); Hessian fly, p. 131-33 (brief general notice).

1889 **Forbes, S. A.** Ill. state ent. 15th rep't. p. 21-34 (observations on life history).

1889 **Lintner, J. A.** N. Y. state ent. 5th rep't, p. 263-64 (injury in 1884 more than usual).

1889 **Riley, C. V. & Howard, L. O.** Burning stubble for Hessian fly. Insect life, 1:294 (discussion of value of this measure).

1890 **Forbes, S. A.** Ill. agric. exp. sta. Bul. 12. p. 377-79 (brief general notice); Ill. state board of agric. June crop report (brief notice).

1890 **Koebele, Albert.** Hessian fly in California. Insect life, 2:252. (record of its occurrence); Hessian fly. U. S. dep't agric. div. ent. Bul. 22, p. 93 (injuries in California).

1890 **Summers, H. E.** Hessian fly. Tenn. agric. exp. sta. Spec. bul. E, p. 6-8 (brief general notice).

1891 **Forbes, S. A.** Ill. state ent. 17th rep't, p. 54-63 (notes on life history).

1891 **McCarthy, Gerald.** N. C. exp. sta. Bul. 78. p. 20 (brief notice).

1891 **Marten, John.** New notes on the life history of the Hessian fly. Insect life, 3:265-66 (observations on development).

1891 **Riley, C. V.** Appearance of wheat infested with Hessian fly. Insect life, 3:339-40 (remarks on the characteristic appearance of infested wheat).

1891 **Riley, C. V. & Howard, L. O.** Hessian fly attacking grasses in California. Insect life, 3:306-7 (records occurrence of two species of Cecidomyia in grasses which subsequently proved not to be Hessian fly).

1891 **Webster, F. M.** O. agric. exp. sta. Bul. v. 4, no. 7, p. 133-58 (general account).

1891 **Woodworth, C. W.** Cal. agric. exp. sta. Rep't. 1890. p. 312-18 (variation in Hessian fly injury).

1892 **Garman, Harrison.** Ky. agric. exp. sta. Bul. 40, p. 3-7 (brief general notice).

1892 **Riley, C. V. & Howard, L. O.** Hessian fly in New Zealand. Insect life, 4:405-6 (record of occurrence).

1893 **Webster, F. M.** Insect foes of American cereal grains with measures for their prevention or their destruction. Insect life, 6:146-50 (notes on prevalence and destructiveness of Hessian fly).

1895 **Howard, L. O.** Imported parasite of the Hessian fly. Insect life, 7:356-57 (note on introduction of Entedon epigonus); Apparent success of the Hessian fly parasite importations, p. 414-15 (successful establishment of Entedon).

1895 **Lugger, Otto.** Minn. agric. exp. sta. 1st rep't ent. p. 117-19 (brief notice).

1895 **Smith, J. B.** N. J. agric. exp. sta. Rep't ent. p. 365, 520-26 (record of injuries in New Jersey and remedial measures); N. J. agric. exp. sta. Bul. 110, p. 1-8 (brief general notice).

1896 **Lugger, Otto.** Minn. agric. exp. sta. 2d rep't ent. p. 11-14 (record of injuries, parasites).

1896 **McCarthy, Gerald.** N. C. exp. sta. Bul. 128, p. 154-55 (brief notice).

1896 **Osborn, Herbert.** Ia. agric. exp. sta. Bul. 33, p. 598-600 (brief general account); Notes on entomological events of 1896 in Iowa. U. S. dep't agric. div. ent. Bul. 6, new series, p. 79-80 (notice of injury, parasites).

1896 **Smith, J. B.** N. J. agric. exp. sta. Rep't, p. 434-35 (injuries in New Jersey).

1897 **Fletcher, James.** Experimental farms (Canada). Rep't, p. 226-27 (notes on injuries).

1897 **Marchal, Paul.** Les Cecidomyies des céréales et leurs parasites. Société entomologique de France. Annales. 66:1-42, 43-47, 51-62, 80-100 (detailed account with original observations on life history, transformations and parasites).

1897 **Webster, F. M.** O. state bd agric. 51st rep't, p. 493-95 (remedial measures for Hessian fly).

1898 **Felt, E. P.** Hessian fly in Pennsylvania. Country gentleman, July 14, 63:546-47 (general account); Hessian fly, Nov. 17, p. 906 (preventive measures recommended).

1898 **Fernald, H. T.** Hessian fly in wheat. Pa. dep't agric. Folder, p. 1-4 (brief general notice).

1898 **Howard, L. O.** Science. new series, 7:246-48 (review of Marchal's paper).

1898 **Johnson, W. G.** U. S. dep't agric. div. ent. Bul. 17, new series, p. 94 (injuries in Maryland).

1898 **Osborn, Herbert.** Hessian fly in the United States. U. S. dep't agric. div. ent. Bul. 16, new series, p. 1-57 (detailed account).

1899 **Felt, E. P.** Hessian fly. Country gentleman, Aug. 10, 64:628-29 (general account); Hessian fly, Nov. 22, p. 942 (rule for ascertaining date for sowing).

1899 **Fernald, H. T.** Pa. dep't agric. Bul. 46, p. 5-8 (brief general notice).

1899 **Fletcher, James.** Experimental farms (Canada). Rep't, p. 173-75 (injuries and remedies).

1899 **Lugger, Otto.** Minn. agric. exp. sta. Bul. 64, p. 551-57 (brief general account).

1899 **Pettit, R. H.** Insects of the year. Mich. agric. exp. sta. Bul. 175, p. 358-61 (brief general account).

1899 **Webster, F. M.** O. agric. exp. sta. Bul. 107, p. 257-88 (detailed account).

1900 **Hopkins, A. D.** W. Va. agric. exp. sta. Bul. 67, p. 239-50 (general account with rule for determining time of sowing).

1900 **Webster, F. M.** O. agric. exp. sta. Bul. 119, p. 239-47 (observations in 1899 and 1900).

1901 **Felt, E. P.** Hessian fly. Country gentleman, May 30, 66:442 (remedial measures); Hessian fly, June 13, p. 486 (request for data); *same* N. Y. farmer, June 13, p. 8; —— June 27, p. 7; Am. agric. June 22, p. 816, col. 1; Hessian fly in New York. Country gentleman, Oct. 3, 66:799-800 (summary account of injuries in 1901 and remedial measures).

1901 **Forbes, E. B.** Minn. agric. exp. sta. Press bul. 13, p. 1-11 (brief general account).

1901 **Garman, Harrison.** The Hessian fly. Ky. agric. exp. sta. Bul. 96, p. 193-98 (period of flight and oviposition).

1901 **Marlatt, C. L.** U. S. dep't agric. Farmers bul. 132, p. 13-22 (brief general account).

1901 **Powers, S.** Hessian fly. Country gentleman, Oct. 31, 66:889 (historical notice and remedial measures).

1901 **Roberts, I. P., Slingerland, M. V. & Stone, J. L.** Hessian fly. Cornell univ. agric. exp. sta. Bul. 194, p. 239-60 (summary account for 1901).

1901 **Slingerland, M. V.** Hessian flies and rag weed. Rural New Yorker, 60:612 (Hessian fly does not breed in rag weed; use of decoy strips); Facts about fly proof wheat, 60:627 (notes on the resistance of various varieties).

1901 **Wadhams, S. W.** Hessian fly. Country gentleman, Sep. 12, 66:740 (results obtained with trap crop); Traps for Hessian fly. Rural New Yorker, Oct. 5, 60:674-75 (method of using trap crop).

1901 **Webster, F. M.** Hessian fly in the middle west. Rural New Yorker, 60:219 (parasites bred abundantly).

1901 **Webster, F. M.** Wheat and Hessian fly. Rural New Yorker, 60:537, 553 (notes on conditions from various localities).

1902 **Felt, E. P.** U. S. dep't agric. div. ent. Bul. 31, new series, p. 22-24 (injuries in 1901).

1902 **Stedman, J. M.** More important insects injurious to wheat in Missouri. Mo. state bd agric. Rep't 1902. Separate p. 23-34 (general account).

NOTES FOR THE YEAR

The following records include some of the more important observations made during 1901. Special attention has been given to forest and shade tree insects throughout the summer. Systematic collecting was pursued at Karner, 7 miles west of Albany, where there is an admirable growth of scrub oaks and small hard pines. These conditions were excellent for securing all the insects affecting these trees, and the results of the season's work, together with that of previous years, will be incorporated in a special bulletin on forest insects now in preparation. The notes relating to the various species mentioned below have been grouped under convenient heads, so that they may be of greater service to the parties interested in the practical aspect of the work.

Fig. 6 Work of woodpeckers on plumtree infested by fruit tree bark beetle (original)

Fruit tree pests

Fruit tree bark beetle, S c o l y t u s r u g u l o s u s Ratz. This insect appears to be on the increase in various parts of the state, as several complaints and personal experience seem to indicate. Our report for 1900, p. 989 (N. Y. state mus. bul. 36) records an attack by large numbers of the beetles on a peachtree Sep. 7. May 22, 1901, in the same locality our attention was attracted to some young plumtrees, from which a large proportion of the bark had been stripped, and investigation showed that the bark and sapwood of these trees were almost alive with pupae of this insect. The woodpeckers had found them out, and had literally stripped the bark from the infested trees and splintered the surface of the wood in their efforts to get at the pupae. A hairy woodpecker, D r y o b a t e s v i l l o s u s Linn., was

observed in the vicinity of the trees, and it was probably this species which preyed on the bark beetles. This is a striking illustration of the value of woodpeckers and their perseverance in digging out such small insects. These pupae were undoubtedly the progeny of the fall brood of beetles, which were observed Sep. 7, 1900, entering trees in large numbers. Aug. 1, 1901, adults of Scolytus in some numbers were entering the bark of a young dying appletree, a victim of Saperda candida, at Pittstown N. Y. The bark beetles gnawed many minute holes about $\frac{1}{16}$ of an inch deep and of the same diameter. Some of these holes were deserted, and in other places the beetles were at work making the primary entrance or beginning a gallery. This observation in connection with the preceding ones shows very clearly that the fall brood of beetles, if there be a distinct one, as is very probable, extends in the eastern part of New York state from Aug. 1 till Sep. 7 or later. This is still further confirmed by our finding at Ripley N. Y. Sep. 5, 1901, beetles entering plumtrees in large numbers.

Fig. 7 Work of fruit tree bark beetle in plum (original)

The presence of pupae and recently transformed beetles in the plumtrees examined May 22 would indicate that the adults would probably have emerged within a short time. There are therefore at least two generations annually in New York state, and the short period necessary for the completion of the life cycle permits more. It may be that more do occur, but there does not appear to be any good evidence to that effect, at present. Another cheering feature in the last mentioned attack was the breeding of numbers of the beneficial parasite known as Chiropachys colon Linn.

Grapevine fidia, Fidia viticida Walsh. This pest has become thoroughly established in some of the vineyards about Ripley N. Y., where it has already destroyed several and is seriously injuring others. An examination of the infested locality early in September 1901 showed that the badly infested area was still quite limited, though the beetles were known to occur in small numbers over a considerable tract. Mr F. A. Morehouse stated that he found the pest most injurious to those vines from which the earth had been plowed away more or less,

FIG. 8 Fidia viticida: *a* beetle; *b* eggs represented natural size under fold of bark and much enlarged at side; *c* young larva; *d* full grown larva; *e* pupa; *f* injury to leaf by beetles; *g* injury to roots by larvae—*b* (in part) and *f* and *g* natural size, rest much enlarged. (After Marlatt, U. S. dep't agric. Yearbook 1895. p. 392)

thus affording the larvae a better opportunity to get at the roots, while those well protected by earth suffered comparatively little. This is certainly worthy of further trial; and, while it can hardly be expected to afford absolute immunity, it may decrease the injury materially. Spraying the vines toward the last of June or early in July with arsenate of lead, preferably using the prepared paste form now on the markets, will do considerable to lessen the damage by poisoning the

beetles before they have had an opportunity to deposit many eggs.

It is worthy of note that this species had been in the eastern part of New York state for a number of years without attracting attention by its ravages. Specimens of this beetle were taken by the late Dr Lintner June 30, 1880, at Schenectady N. Y. and on Virginia creeper at Albany July 20, 1882. The 25th of last July this pest was rather abundant on Virginia creeper at Albany, yet no serious injury to grapevines in this vicinity has been observed.

FIG. 9 Colaspis brunnea, much enlarged (original)

Brown colaspis, Colaspis brunnea Fabr. This pest, in company with Fidia viticida Walsh and Systena hudsonias Forst., was received from Fredonia N. Y. with the complaint that grapevines had been seriously injured. Much of the harm was undoubtedly caused by the Fidia; but, as this species of Colaspis was present in considerable numbers, and as it is well known as an enemy not only of the grapevine but also of strawberry plants, it probably caused considerable injury. This species was also taken in very small numbers on hard pine, Pinus rigida, and on willow at Karner N. Y. July 8. The beetles are very general feeders, having been previously recorded as feeding on such unlike plants as beans, clover, buckwheat, strawberry, potato and corn.


FIG. 10 Appletree borer, adult beetle

Round-headed appletree borer, Saperda candida Fabr. A number of severe injuries by this well known pest have been brought to notice during the year. It was quite common and destructive at Pittstown and vicinity, as reported by W. C. Hitchcock, and the reason for this is found in the fact that little or no attention

is paid to its operations. It was not only seriously damaging young trees there, but it was commonly present in greater or less numbers at the base of the older ones. It was found quite abundant in an orchard of young trees in East Greenbush, where seven good sized grubs were taken from the base of a small tree not over 3 inches in diameter. There is no doubt that persistent and thorough digging or cutting out of these grubs and the use of a protective wrapper at the base of the trees are all that is necessary to control this pest. The cost of these measures is very slight compared with the value of the orchard.

Red-headed flea beetle, Systena frontalis Forst. The destructive tendencies of this little black, red-headed flea beetle have been noticed in a recent report. This year it was received, in company with other insects, as a depredator on grapevines. It probably, as in preceding cases, had bred in weeds, and, when numerous, turned its attention to more valuable plants.

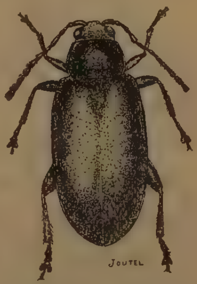


Fig. 11 Red-headed flea beetle much enlarged (original)

Forest tent-caterpillar, Clisiocampa disstria Hübn. This insect has been a most serious pest in New York state for the last four or five years, and in localities here and there it has proved exceedingly destructive this season. The outbreak of 1901, so far as could be learned, was much more limited in area than in earlier years and confined largely to sections adjacent to where the insect had been specially abundant previously. The caterpillar appears as a rule to be unable to exist in large numbers in one locality for more than four or five years in succession. This is probably to be explained by the local activity of natural enemies. Another marked feature has been the increasing predominance of the pest in orchards. It is perhaps hardly necessary to add that most of the injuries in orchards could have been prevented by timely and thorough spraying.

Cenopis diluticostana Wlsm. The peach twig moth, A n a r s i a l i n e a t e l l a, is a well known boring pest of peach twigs, but the results of this summer apparently show that some other species may be involved and produce very similar injury. The 22d of last June Mr C. H. Stuart of Newark N. Y. sent in peach twigs affected with what he thought was the common peach twig borer. On breeding it, however, it proved to be the above named insect, which was kindly determined by Prof. C. H. Fernald. The notes made at the time on the material sent are of interest and are here transcribed. All the buds had been killed on three or four twigs, 4 to 6 inches long, and those bearing green leaves also had masses of gum of considerable size. The young fruit had also been attacked somewhat. The bark and the sapwood under the masses of fresh gum had been seriously mined. In some places the mines were linear and in others were expanded and very broad. Mr Stuart subsequently wrote that there was hardly a branch of the tree that was not affected, and that many apricot, plum, cherry, apple, peach, willow and other trees for miles on each side were injured, though such an attack had not been previously noted. The trees recovered later, but many small branches were killed.

This insect was described by Lord Walsingham in 1879 in his *Illustrations of typical specimens of Lepidoptera Heterocera in the collection of the British museum*, pt 4, "North American Tortricidae," p. 18. The specimen from which his description was drawn up came from the eastern states of North America. Prof. Fernald in 1882 redescribed this species as C e n o p i s q u e r c a n a in the transactions of the American entomological society, 10:69. His description of the moth is herewith transcribed.

Head, palpi and antennae, reddish gray in the males, concolorous with the thorax and fore wings in the females. Thorax and fore wings dull rust red. Basal patch, median and subapical bands lighter in the males and inclining to yellowish on the costa with strong greenish reflections when seen in an oblique light, showing most strongly in the females. Fringes lighter. Hind wings and abdomen above, light fuscous, lighter beneath. Underside of forewings dull reddish, fuscous on the cell, the lighter markings of the upper side scarcely showing. Expanse, male 14 mm; female, 16 mm.

The specimens from which the above description was drawn were bred from leaves of oak by Prof. Comstock, probably at Ithaca N. Y. and from cultivated cherry by Miss Murtfeldt in Missouri. Prof. Fernald states that there are no other records concerning this insect; and, while most of the above recorded injury to peach twigs may possibly be the work of the peach twig borer, it is certainly of interest to know that this species also attacks the peachtree, and further investigation may show that it is responsible for considerable of the injury. The one bred specimen pupated in a leaf. The empty pupal case was about $\frac{3}{8}$ inch in length, light brown in color, and the dorsum of each of the abdominal segments bore two trans-

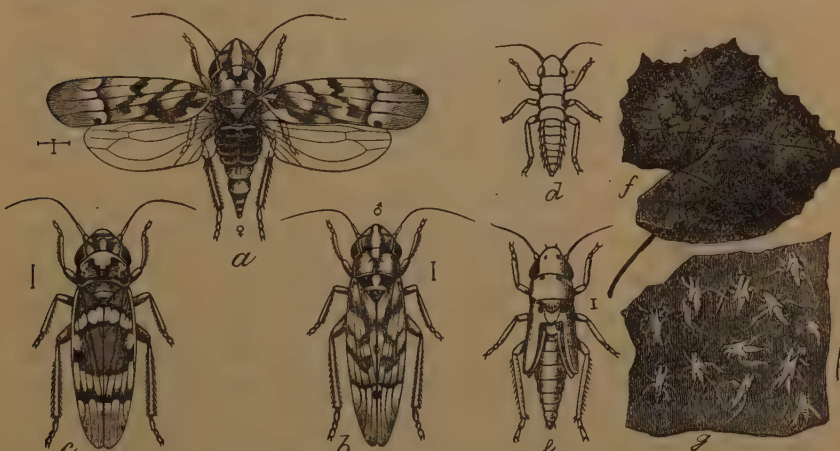


FIG. 12 Typhlocyba (sp.). *a* T. comes Say, female; *b* T. comes Say, male; *c* typical form of T. vitifex; *d* larva; *e* pupa; *f* appearance of injured leaf; *g* cast pupal skins. (After Marlatt, U. S. dep't agric. Yearbook 1895. p. 401)

verse rows of serrations, the anterior rows being very well developed and consisting of from seven to 10 dark, chitinous teeth. The cremaster is dark brown, blunt at the extremity and tipped with six or eight rather stout, though small, recurved spines.

Grapevine leaf hopper, Typhlocyba comes var. vitis. This little leaf hopper is very familiar to many grape growers, and during the past season it has been exceptionally abundant in parts of the grape-growing districts of Chautauqua county. The foliage in many vineyards was very seriously affected, parti-

cularly the shaded, underleaves. The work of this species was less noticeable in vineyards where clean culture was the rule, although the pest was very generally present.

Shade and forest tree pests

Elm leaf beetle, G a l e r u c e l l a l u t e o l a Müll. This imported species continues to be a serious enemy of European elms in Albany, Troy and vicinity. The depredations of this pest have been so severe as to lead to the maintenance and operation of two power spraying outfits by the municipality of Albany. Two are also in operation by a private owner in Troy, where they are kept busy throughout the spraying season, each individual paying for the treatment of his own trees. The general condition of the shade trees in both cities is much improved by this work, and, considering all the trees in the streets of both cities, the results are decidedly in favor of Albany. This is probably due almost entirely to the fact that it is much more economical to take a street at a time and spray all the trees than to go hither and thither as desired by private persons. The former is possible only where the city undertakes to spray all the trees on the streets, while the latter must obtain where spraying depends on the will and financial ability of the owner of the abutting property. It might be well to add that as a rule Albanians neglect the trees on their own premises, while people of Troy who have spraying done, invariably include the trees on the premises as well as those in front of the property. The elm leaf beetle has almost undisputed sway in the poorer parts of Troy, because the residents can not afford to have their trees sprayed; while in Albany, these, as well as those inhabited by the wealthier class, are treated, with most beneficient results, because it is in these poorer quarters that shade is most urgently needed. It therefore seems to me advisable to urge the prosecution of such work, when necessary, on municipalities,

FIG. 13 Elm leaf beetle, adult, much enlarged (reduced from Howard, U. S. dep't agric. Yearbook 1895)

rather than to allow it to depend on the enterprise of private individuals, solely because it means the greatest good to the greatest number at a minimum expenditure. This imported pest is slowly extending its range northward of Albany and Troy, and, in some localities where no spraying is done, it is this season proving a scourge to both European and American elms.

The cost of spraying shade trees in cities and villages is a very important matter; and in a former bulletin[1] some attempt was made to ascertain the expense connected with such operations. Figures at that time gave the cost as ranging from about 15c to 56c a tree. Some recent estimates have come into my possession regarding the cost of spraying in Albany and its immediate vicinity. Mr H. W. Gordinier states that in Lansingburg N. Y., where he had a contract to spray all the trees in the village and where most of the elms are very large, the cost per tree for one spraying averaged about 23c, while in Troy, where he sprays the trees of private individuals here and there over the city and is necessarily obliged to travel considerably to go from one lot of trees to another, the cost of spraying ranges from 50c to 60c a tree for each spraying. In both cases the rather more expensive arsenate of lead was used. Both of these figures apply to elmtrees infested with the elm leaf beetle; and, as all who have had experience with this pest know, it requires very careful and thorough spraying in order to obtain satisfactory results. The average cost per tree for spraying in Albany in 1901, using 5 pounds of Bowker's disparene to each 100 gallons of water, was 22c, and the average number of trees sprayed per day by each power spraying outfit was 40. Two were operated under one foreman. However, it was found that, where the trees were small and of a nearly uniform size, such as Norway maples about 30 feet in hight, 180 trees could be sprayed in one day.

The village of Saratoga Springs undertook to spray its many large maple trees, ranging in hight from 20 to 80 feet, in 1900,

[1] N. Y. state mus. Bul. 20. 1898. p. 21-22.

and for that purpose it purchased two power spraying outfits, each provided with an elevating apparatus such as is commonly seen on repair wagons of electric roads. With such an outfit it was found that the average cost per tree for each spraying was 17¼c. Mr Wells, superintendent of streets, is of the opinion that this elevating apparatus is a great saver in time and money. It should be borne in mind, however, that the maple trees at Saratoga were not infested with the elm leaf beetle, but with the forest tent-caterpillar, and that spraying in the case of the latter insect is much easier than in the case of the former, and the cost would therefore be much less.

The work in Albany was done under the civil service regulations, and, owing to local conditions, the foreman was unable to exercise desirable selection in the choice of his men. Mr W. S. Egerton, superintendent of parks, in commenting on the situation remarks as follows: "An active energetic foreman, understanding thoroughly the requirements of the service, and having authority to *select* his men for special qualifications as to handling and climbing ladders and spraying properly, could cover much more territory, more effectually and at much less cost per tree, than the eight hour limit and the civil service regulations permit under the present system." He further remarks concerning the force employed in the operation of the power outfit, which in the city of Albany consisted of a driver, a motorman and two spraying men: "The force used on the motors could, under private enterprise, be reduced to three men to each motor, the motorman and driver being one and the same person and two sprayers, making three operators."

It will be seen by the above that there is an opportunity even with these comparatively low figures to reduce still further the cost of spraying trees without marring the efficiency of the work. The trouble with a great many persons wishing to have spraying done is that they fail to see the necessity of insisting on thorough work, and they are very apt to consider the work cheap if a large number of trees are covered with the poison, whether or not the work be thoroughly done. As a matter of

fact, such work may be very dear, because it may accomplish practically nothing. The public need to appreciate the fact that, unless spraying is thoroughly done, it is better not to attempt any such work.

European willow gall midge, Rhabdophaga salicis Schrk. European willows are used to a considerable extent in and about Rochester and other nursery centers for the purpose of binding nursery stock into small bundles; and any attack made on plantations of young willows is therefore of some economic importance. Mr H. C. Peck called our attention in November 1898 to some galled willows which he found in a small block owned by T. C. Wilson of Brighton N. Y. The insects live in the stems of the willows, and by the production of their galls made them brittle and unfit for tying purposes.

FIG. 14 Venation of Rhabdophaga salicis, much enlarged (original)

Repeated attempts were made to secure the identification of this insect from European authorities but, owing to rough usage and possibly inspections of mail matter, nothing more definite than a generic reference could be obtained, till fresh galls were sent in the spring of 1902 to Prof. J. J. Kieffer, the well known authority on this group, who kindly determined the species. These repeated failures rendered it advisable to characterize the insect, and the following description was in type before the determination was made and it is hoped that this study of a member of the genus Rhabdophaga may prove of value to those interested in this group.

The extreme length of the adult female is about 3 mm. The eyes are black, finely granulated, emarginate anteriorly, confluent in the male and nearly so in the female. The antennae

are 17 jointed and in the male are about the length of the insect. The first joint is subconical, second ovoid and the remainder are pediceled, the pedicel being nearly as long as the enlarged part. The bulb of each segment is irregularly setose, with the hairs as long or longer than the entire segment. Certain of the light dots are connected by lighter strips which appear on focusing to be slightly below the surface of the segment. The female antenna is about one half the length of the insect, the first and second segments being about the same as in the male. There are lines of light dots on each segment much like those recorded for Diplosis setigera Lintn. Each joint is also irregularly ornamented with setae, about as long as the segments, that arise from large, pitlike depressions. The characters of male and female antennae are shown on plate 2, figures 5, 6. The two distal segments are occasionally fused together. The palpi are four-segmented, the two distal joints are nearly equal in length, the basal joint is the shortest and the second intermediate. The thorax is ornamented with two converging rows of silvery hairs, and a short row of smaller ones occurs on each humeral angle, and the metathorax is tipped with a transverse row of the same vestiture. The wings are sparsely covered and well fringed with fuliginous hairs. The venation is represented in figure 14. The halteres are long, slender and tipped with pale yellow. The legs are very long and slender, claws bifid, toothed and with well developed empodium

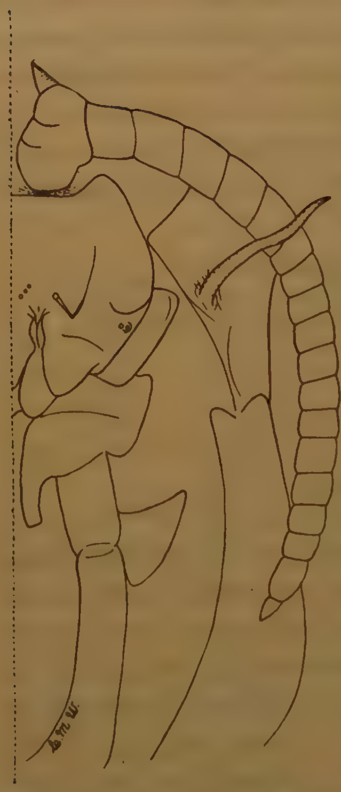


FIG. 15 Ventral aspect of pupal skin of Rhabdophaga salicis, much enlarged (original)

(pl. 2, fig. 3, 4). The distended abdomen of a gravid female is dark red, the color evidently being derived from the contents. The abdomen of the male is nearly black, and the clasps are tipped with two very short, minute teeth.

The puparium is subconical, about 3 mm long, with the anterior two thirds a dark straw yellow and the posterior third a dark rufous.

The cephalic horns of the pupa are pointed, confluent at the base and of a hight equal to their greatest width. The prominent dorsal processes are slender, slightly crooked when observed from the side and with a length equal to about one third of the diameter of the pupa (fig. 15). The slender, setaceous processes are shown at plate 2, figure 2. The pupal mandibles are four toothed, tipped with light brown chitinous and the ventral tooth is nearly twice the size of the one next it which in turn is larger than the others. All curve some and taper to acute points.

The larva is stout, orange red, with 11 easily distinguished segments. It is about $3\frac{1}{2}$ mm long, and the "breast bone," or sternal spatula, is nearly black, enlarged slightly at both extremities and two toothed anteriorly (pl. 2, fig. 1).

FIG. 16 Caterpillar of carpenter moth (original)

The reddish orange eggs are deposited on the leaves by captive flies in irregular clusters or groups of three to six or more, frequently side by side. They are lanceo-elliptic in outline and about $\frac{3}{10}$ of a mm in length.

This insect produces many celled galls in the stems of small willows. At the time the insects appear, the bark over the infested part turns brown or black and, the pupae working partly through a circular orifice, discloses the imago. The pupal case remains projecting from the gall, and usually there

are enough individuals in one gall to give an empty one a very characteristic appearance on account of the whitish, projecting pupal cases. A gall is represented at pl. 4, fig. 1.

Adult flies were obtained from May 22 onward, from material received on the 10th, and on the 31st a parasite was bred. This was kindly identified by Dr Ashmead of the United States national museum as Tridymus salicis Nees, a species recorded for the first time in America. Tridymus metallicus Ashm. was bred in small numbers from galls received in the spring of 1902 and Polygonotus salicicola Ashm. was reared in numbers. This abundance of parasites leads us to hope that natural agents will soon control this pest. Twigs received June 3, 1901, directly from the willow plantation had disclosed some flies, showing that the period of emergence extends over a number of days. Mr Peck further states that Mr Wilson has been in the habit of opening cases of imported stock near the block of infested willows; so it would be comparatively easy for them to become infested.

FIG. 17 Work of carpenter moth caterpillars, pupal case and adult (original)

Carpenter moth, Prionoxystus robiniae Peck. This is a serious enemy to maple, oak and ash trees in certain sections of New York state. Its destructive work at Ogdensburg was brought to my attention by Miss Mary B. Sherman of that place, and through her some interesting examples of the borers' work in sugar mapletrees were secured. One third of a section of a tree about 15 inches in diameter was fairly riddled with the large burrows of the caterpillar of this insect. It was so abundant as to

ruin a number of fine trees in that locality and necessitate their removal. The work of this pest at Buffalo was brought to my notice by Mr M. F. Adams of that city, and through his kindness I have been able to secure good examples of the insects' work in ash and to observe its operations in oaks. This species also occurs on Long Island. All the examples of its work seen by me show that the full grown caterpillars prefer to run their burrows at some depth in the wood, and that as a rule they run so close to and communicate so freely with one another as to destroy the value of infested trees for timber. This insect also causes large unsightly wounds wherever its burrows come near the surface. Caterpillars about to pupate frequently take refuge in these channeled wounds, from which the pupae work themselves partly out before the disclosure of the imago. The eggs are probably deposited in any available crevice, where they adhere to the bark rather firmly. A piece of root which had been bored by the willow curculio, Cryptorhynchus lapathi Linn., was lying in a breeding cage, and a female Prionoxystus embraced the opportunity to deposit six or seven eggs well within the burrow.

Apparently the females do not hesitate to oviposit before the appearance of males. Some eggs which were found in the office hatched, possibly without being fertilized, but it was impossible to prove the latter point. Dissection of a well distended female which probably had deposited no eggs, showed that she contained 269 well formed ova and 133 which were partly developed, making a total of 402.

Leopard moth, Zeuzera pyrina Fabr. Late in January a communication was received from C. H. Stuart, Newark N. Y., accompanied by an imported quince seedling infested with the larva of this notorious pest. It was stated in the letter that all of the stock with which this stock came would be fumigated before it was set out. This pest, as is well known, has proved and is now a very serious enemy to shade trees in and about New York city; and it is only a question of time when it will become more widely distributed in the United States. It is one

of those forms that can not be controlled by fumigation; and, inasmuch as it is known to have been established in New York city and vicinity for nearly 20 years, it is surprising that it has not spread more rapidly. See pl. 3 for an illustration of the insect and its work.

Birch leaf bucculatrix, Bucculatrix canadensisella Chamb. Last fall the white birches all about Albany were very badly affected by a small caterpillar which ate away the tender, under portion of the leaves. The skeletonized parts dried, turned brown, and the trees looked much as if they had been injured by fire. This year the pest appears to be even more numerous, having been very abundant about Albany. Its work was also observed all through the western two thirds of Massachusetts, and it has been reported as quite injurious in several localities in the northern part of New York. This attack is not unprecedented, though of considerable interest on account of its covering so large a territory. This insect was reported to Dr Lintner as injurious about Scottsville, Monroe co., in 1886, and in 1891 it seriously injured birches about Ausable Forks N. Y.

The parent of this caterpillar is a little, brownish white moth with a wing spread of but $\frac{3}{8}$ of an inch. The caterpillar is a delicate, yellowish green creature about $\frac{1}{4}$ of an inch long when full grown. During the last half of August and the first half of September many can be found curled up under a white, silken covering known as the molting cocoon. Later a beautiful, white, ribbed cocoon will be constructed in which the winter is passed. Pl. 4, fig. 5 illustrates well the appearance of the insect in its various stages.

Valuable trees can be protected by spraying with an arsenical poison, preferably arsenate of lead, taking special pains to get the poison on the under surface of the leaves. It is to be expected that natural agents will soon reduce the numbers of this tiny pest and thus prevent the ultimate killing of the trees.

Golden oak scale, Asterolecanium variolosum Ratz. White oak twigs received from Yonkers N. Y. Sep. 16 were literally covered in places with this insect. The scales

are a little less than $\frac{1}{16}$ of an inch in diameter, nearly circular in outline, strongly convex and varying in color from a light golden yellow to a dark brown. They are usually bordered by a line of white excreted matter, and on badly infested twigs the edges of one scale may overlap those of another. The removal of a scale will reveal a distinct hollow in the bark, showing that

Fig. 18 Pseudococcus aceris: *a* adult females on leaf; *b* young female and males on bark. Natural size. (After Howard, *Insect life*. 1894. 7:235)

the growing bark has developed around rather than under the insect. This scale insect has been quite injurious in earlier years to English oaks at Geneva N. Y., apparently doing more harm to large trees.

The young of this scale insect begin to appear in the latitude of Washington D. C. about the first of May, but Prof. Lowe, in his report for the year 1895, states that at Geneva N. Y. the

young had not begun to appear May 29. The young may be expected in the latitude of Yonkers about the middle of May and later; and thorough spraying at intervals of about a week, as long as the young appear, with kerosene emulsion, diluted with nine parts of water, will probably be found very effective in checking this pest. Aim to cover every part of the infested tree with the insecticide.

The small Lecanium nigrofasciatum Perg. has proved a rather serious enemy to soft maples in Albany. This scale insect has been so abundant on some small trees as nearly

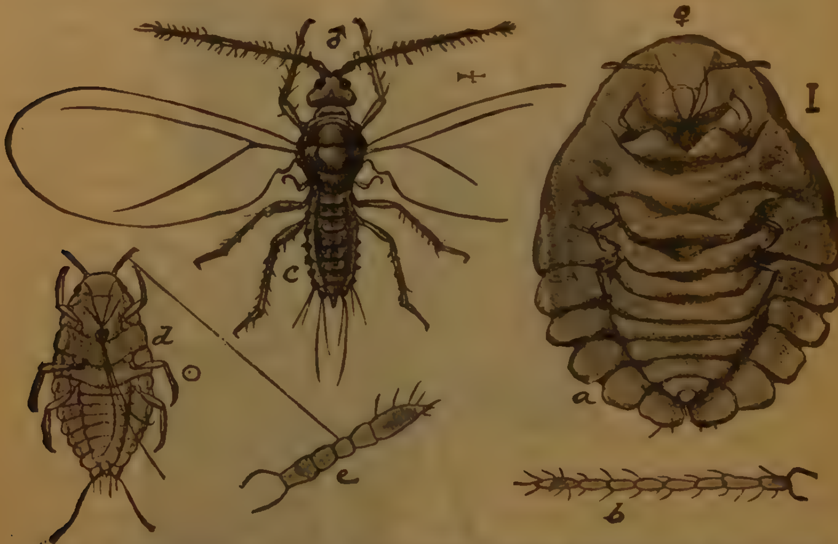


Fig. 19 Pseudococcus aceris: *a* adult female; *b* antenna of same; *c* adult male; *d* young larva; *e* antenna of same—*a*, *c*, *d* greatly enlarged; *b*, *e* still more enlarged. (After Howard, *Insect life*. 1894. 7:237)

to cover the under surface of the limbs, and so much honeydew was exuded that the walks beneath were kept moist. The severe drain on the trees prevented much growth and resulted in killing a number of the smaller limbs. Badly infested twigs have a marked sour, semiputrid odor due in all probability to the decomposition of the honeydew. Young began to appear in Albany about June 14, and by July 15 they were about .5 mm long and were thickly set on the smaller twigs (pl. 4, fig. 2).

Pseudococcus aceris Geoff. This comparatively rare species was observed in immense numbers on the bark of a hard maple at Albany N. Y., August 6. It was also observed in considerable numbers on hard maples at Worcester Mass. The male cocoons were present in thousands and in places formed large white masses on the trunk, giving a tree the appearance of being affected by a fungus. Some immature individuals were wandering over the masses of the male cocoons. The leaves were also badly affected. The cottony remains of adults were abundant, and here and there old females were still producing young, as a number of very small individuals were observed, and partly grown ones were assembled on the under surface of the leaf in long rows on both sides of the principal veins. There is a marked, subacid, not unpleasant odor about this species when present in large numbers. It is not nearly so offensive as Lecanium nigrofasciatum Perg.

Chermes pinicorticis Fitch is always more or less injurious to white pines in Washington park, Albany, but this year it has been exceptionally abundant, not only giving considerable portions of the trunk a whitewashed appearance but literally plastering the under surface of many limbs. A number of these pines, as a consequence, have a thin foliage and are sickly. It was also observed in numbers on white pines at Round Lake N. Y.

Garden and other insects

Blister beetles. Several species were brought to notice through the depredations of the adults on various plants. The striped blister beetle, Epicauta vittata Fabr., attacked beets, potatoes, beans and tomatoes about the middle of August, at Valatie, Columbia co. It was reported as very numerous and to have devoured all the beets and tomatoes and then to have attacked potatoes. The exceedingly common black blister beetle, Epicauta pennsylvanica DeG., suddenly attacked sugar beets about the same time at Cobleskill, Schoharie co., and some patches were destroyed. The latter part of August, this species was reported as injurious to potato vines

and China asters at Charleston Four Corners, Montgomery co., the beetles appearing to prefer the half grown aster blossoms.

Fig. 20 Striped blister beetle, enlarged (original)

Fig. 21 Black blister beetle, enlarged (original)

The margined blister beetle, Epicauta cinerea Forst., is another common and occasionally a very annoying species.

Owing to the fact that several species of these beetles are known to be beneficial in the grub stage, preventive rather than

Fig. 22 Margined blister beetle, enlarged (original)

destructive measures have uniformly been urged for their suppression.

Pale striped flea beetle, Systena taeniata. This little pest was very common and quite injurious in an eight acre bean field at South Byron, Genesee co. The field had been sown the previous fall to wheat, which was destroyed in early spring by Hessian fly, and then it was again plowed and planted with beans. The weeds growing in the grain undoubtedly supplied the flea beetles with shelter and provender, and, when they were

destroyed, the insects waited with more or less patience for the appearance of something green. It is well known that this and allied species thrive on weeds, and, while clean culture may not be possible in a grain field, there is rarely a necessity of sowing after grain a crop which these little pests can seriously injure. If such a course be unavoidable, they can be controlled by spraying the plants early with a poisoned bordeaux mixture.

FIG. 23 Pale striped flea beetle, enlarged (original)

Fringed anthomyian, Phorbia ? fusciceps Zett. The bean fields in several parts of the state suffered considerably from the attack of some insect. The trouble was first brought to our attention by J. F. Rose, South Byron, Genesee co., and July 10 a number of fields were visited in his company. A great many bare stalks occurred in several fields, and on investigation it was found that much of the injury of this character must have been caused by a maggot working on the delicate plumule before the plants broke ground and probably before the process of germination had much more than begun. A number of these bare stems were found to be even then infested with dipterous maggots, which were working in the stalks and producing large cavities surrounded by brownish, partly decayed tissues. The species was identified provisionally from larvae taken under such conditions. Unfortunately, we were not able to obtain adults and thus make an authentic determination possible. The greatest injury was observed in a field which had been sown to wheat the previous fall and through the activity of the Hessian fly had been destroyed. This field had been plowed and planted to beans. The reason for greater injury on such fields is probably found in the fact that grain offers abundant food for such insects, and, when this is suddenly destroyed, the insects naturally turn to the most available crop, and in the case of a thinly planted one like beans, serious injuries may result. Newspaper reports mention a similar trouble in Orleans county.

Cacoecia parellela Rob. Moths of this species, kindly identified by Prof. C.H. Fernald, of the Massachusetts agricultural college, Amherst, were bred July 22 to 28 from larvae occurring singly in nests composed of the webbed together terminal leaves of sweet melilot shoots. The caterpillars were quite abundant June 4 to 13 in one small patch of this common weed at West Albany. This species is comparatively new to economic entomology, having so far as known been noticed but twice. It was bred by Dr J. B. Smith,[1] state entomologist of New Jersey, from similar webs occurring on cranberry bushes, and he also observed it on adjacent "loose strife." Larvae of apparently the

Fig. 24 Cacoecia paralella: a moth, b caterpillar, c pupa, all much enlarged (original)

same species were observed on cranberry near St Anthony park, Minn., by the late Dr Otto Lugger,[2] formerly state entomologist of Minnesota. William Beutenmuller records it as feeding on willow and aster.[3]

As the larvae differ somewhat in color, being characterized as reddish with yellow heads by Dr Smith in his report for 1892, a description is given herewith.

The full grown caterpillar is about $\frac{7}{8}$ inch long. Its head and thoracic shield are amber colored. The latter is bordered laterally and posteriorly with irregular black markings and orna-

---

[1] N. J. state agric. exp. sta. Rep't 1892. p. 440.
[2] University of Minnesota. Agric. exp. sta. Bul. 61. 1898. p. 283.
[3] Amer. mus. nat. hist. Bul. 4. 1892. p. 80.

mented with a pair of dark spots on the anterior border near the median line. The body is a rather dark green and bears large, whitish, quite conspicuous tubercles, each with one to three hairs or setae. The anal plate is rather prominent and dark brown posteriorly. The true legs are black and the false or prolegs are a yellowish green color. Described from a number of living specimens. The pupal shell is about $\frac{1}{2}$ inch long, brown in color. The cremaster is black and ornamented with about eight or nine recurved hooks.

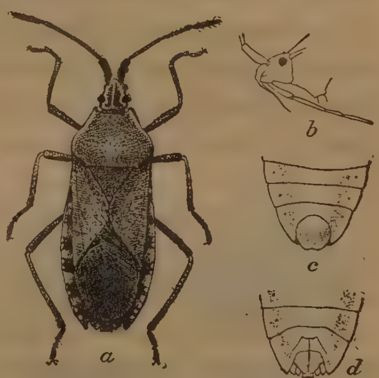


FIG. 25 Squash bug: *a* adult female twice natural size; *b*, *c* and *d* details of structure more enlarged (after Chittenden, U. S. dep't agric. div. ent. Bul. 19, new series)

Squash bug, A n a s a t r i s t i s DeG. This common and disgusting pest of the squash and other vines has been unusually troublesome and destructive the past season. A number of complaints have been received from various sections of the state. The experience of state botanist Peck may well serve as an example. After an absence of about two weeks, he took 63 adult bugs from four hills of squashes, and two hills had but a single plant each. The squash leaves were fairly covered with eggs, and others were deposited on adjacent raspberry and plum leaves, as well as on cucumber vines.

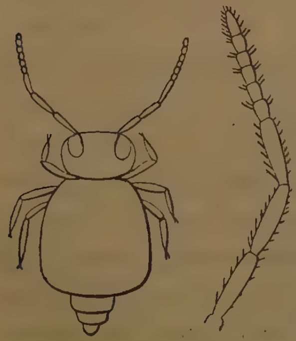


FIG. 26 Garden flea, much enlarged (after Fitch)

Garden flea, S m y n t h u r u s h o r t e n s i s Fitch. Though this insect is said to occur abundantly during May and June in gardens in New York state, it is rarely brought to the attention of economic entomologists. Its small size and quick movements have undoubtedly deterred many from trying to capture it, but this difficulty was ingeniously solved by Mr C. E. Ford, Oneonta N. Y., who

smeared molasses on a piece of cardboard, gummed it in the bottom of a small box and, while the molasses was still fresh, clapped it over the insects. Their jumping brought them into contact with the sticky surface, and there they remained secure and alive till they reached the office. Mr Ford stated, under date of May 31, that this species was particularly injurious to melon and squash vines. The general form of the insect, though much enlarged, is shown in the accompanying figure. It is a broadly oval, black or dark colored insect less than $\frac{1}{10}$ of an inch in length, wingless but provided with short, thick hind thighs and also a peculiar, ventral springing fork. The latter structure is peculiar to insects belonging to the same order, Thysanura, and it is on account of this peculiar organ that these insects are frequently known as "springtails." Dusting affected plants thoroughly with plaster or ashes or, better still, spraying them with a poisoned bordeaux mixture should control the pests.

Rabbit botfly, Cuterebra ?cuniculi Clarke. This species, closely related to the "warble fly" of cattle, which is frequently known as "grub-in-the-back," was twice brought to notice during the season—once, when infesting Belgian hares, and in this instance the identification was in all probability correct. The second case was that of a kitten four months old, owned by D. F. Meskil of Highland Falls N. Y. The history of the case as stated by Mr Meskil is as follows. About Aug. 7 the kitten "developed an abrasion on his side, midway between the hind and fore quarters and 1 inch below the spine. It rapidly developed into a suppurating protuberance," and by the 16th it was "an inch and a half long and as thick as a man's thumb." It will be noted that this is just about the position where this larva develops on the rabbit. The sore was cut open, and a grub $\frac{3}{4}$ of an inch long and nearly half an inch in transverse diameter removed. The grub resembles the one from the Belgian hare very closely, and they probably belong to the same species. It only remains to add that the kitten recovered rapidly after the removal of this disgusting pest. The accom-

panying figure gives a very good idea of the appearance of this grub. An examination of one, with even a common hand lens, will show that its dark brown color is due to a multitude of pointed, chitinous pyramids, which literally cover the nearly white skin, and one has only to imagine such a creature working about in a sore, to obtain some idea of the pain inflicted. The parent fly is about the size of a bumblebee and much resembles that insect. It has a black head, yellow brown hairs on the dorsum of the thorax, yellow hairs on the first segment

FIG. 27 Cuterebra cuniculi: side view; *a* larva, ventral aspect; *b* pupa, lateral view; *c* anterior extremity; *d* hooks and anterior spiracles of larva — all enlarged. (After Osborn, U. S. dep't agric. div. ent. Bul. 5, n. s. p. 109)

of the abdomen and the remaining segments of a blue-black color. It is represented in the accompanying figure.

European praying mantis, Mantis religiosus Linn. This beneficial insect was discovered by Mr Atwood in 1899 at Rochester N. Y., where it had undoubtedly been brought on imported nursery stock. Several notices of the introduction of this insect have been published by Prof. M. V. Slingerland, who has also issued an interesting bulletin[1] on this species. It has now become quite abundant in Rochester, and last spring an effort was made, through the kind cooperation of Mr Atwood, who sent 227 egg clusters, to introduce this beneficial insect into

[1] Cornell univ. agric. exp. sta. Bul. 185.

other parts of the state. Seven to eight egg clusters from this lot were sent to the following persons: C. L. Allen, Floral Park, H. S. Ambler, Chatham, M. H. Beckwith, Elmira, R. L. Darrison, Lockport, O. Q. Flint, Athens, S. H. French, Amsterdam, J. T. Gaylord, Poughkeepsie, G. S. Graves, Newport, W. G. Hitchcock, Pittstown, S. B. Huested, Blauvelt, H. D. Lewis, Annandale, E. H. Mairs, Irvington-on-Hudson, L. L. Morrell, Kinderhook, Paul Roach, Quaker Street (Schenectady co.), E. T. Schoonmaker, Cedar Hill, C. H. Stuart, Newark, Franklin Taber, Poughkeepsie and C. L. Williams, Glens Falls. Each lot was also accompanied by a letter directing the recipient to keep the eggs cool and as soon as possible to tie them to the stem of some bush or to a low branch of a tree. The persons were requested to keep watch for the hatching of the eggs and to report concerning them. A copy of Prof. Slingerland's bulletin was also sent to each. In addition, a number of egg clusters and a few living young were distributed about Washington park, Albany, some in the northeast and a number near the northwest corners of the main part of the park; 15 egg clusters were distributed May 22 about the premises of H. A. Unger, Hillview, East Greenbush; and about as many June 8 in the gorge below Dean's mill, Coeymans N. Y. A number of egg packets were taken to Saratoga N. Y. May 4, a few placed in promising locations, and others given to the street, water and gas commissioners of that village.

It is naturally somewhat difficult for one unfamiliar with this insect to be certain that young mantids hatched from the eggs, and in the majority of instances negative results have been reported. Still it is well to have these localities on record because some of the insects may have escaped unobserved. Mr G. S. Graves of Newport states that during the summer a Mr Morey found one dead adult in a whey vat and a living specimen in the house. They were identified by comparing with an illustration in a dictionary. Mr O. Q. Flint, Athens, reports that some of the egg masses looked as if they had hatched. W. C. Hitchcock, Pittstown, states that he found one freshly laid egg mass. R. L. Darrison, Lockport, succeeded in obtaining between

July 2 and 5, 100 young mantids from an egg mass kept indoors. The young were set at liberty in the vicinity. None of the egg masses put out of doors developed any insects, Mr Darrison states. Messrs Allen, Ambler, Beckwith, Huested, Morrell, Roach, Schoonmaker, Stuart, Taber and Williams reported negative results. J. T. Gaylord of Poughkeepsie was unable to find any young mantids or to discover recently deposited egg clusters; but E. H. Austin of Gaylordsville Ct., to whom he sent a few eggs, discovered several living mantids about an inch or so in length. H. D. Lewis of Annandale found several fresh egg clusters, some of them over 100 rods from where the eggs were planted last spring. This insect should have become established in Albany or its vicinity, but up to the time when this report is submitted, nothing very encouraging has been discovered. Apparently, quite a proportion of the egg clusters failed to hatch, though a number of the young were obtained in the office.

Croton bug, Phyllodromia germanica Linn. An excellent remedy for this household pest was reported on last May by Mrs H. D. Crane, Montclair N. J., who found powdered borax to be the best of a number of substances tried. She states that it must be used freely all around the cracks and corners and so placed that the bugs can not get to water without going over it. Her neighbors also had excellent success with this substance. This insect is such a serious pest in some houses that records like the above should be given wide circulation for the encouragement of others. As noted in earlier publications, Hooper's fatal food has also been used very successfully. There are probably other equally good proprietary remedies, but nonpoisonous ones should receive preference about houses.

Unusual abundance of southern forms

A study of climatic conditions is not without value, since it gives a basis for forecasting the probability of insects being able to live in various sections of the country. This is of considerable importance in the case of injurious and beneficial

species, because we are thereby able to ascertain to some extent the limiting agencies controlling them, and the more that is known along these lines concerning various forms, the more accurate will be our judgment as to their possible range. The present year has been marked by the presence in abundance of several interesting species, three of which are mentioned below. The reason for their occurrence in great numbers is probably found in unusually favoring weather conditions, particularly in the more than normal warmth. A study of the monthly mean temperatures during the growing season in the Hudson river valley for this and the preceding four years bears out this conclusion somewhat. The following tables, compiled from the records of the New York state weather bureau and from those of the New York section of the national weather bureau, show this fairly well.

Monthly mean temperature of the Hudson valley region

	May	June	July	August	September
1897	59	64.3	73.6	68.6	61
1898	57.3	68.8	73.7	71.8	65.9
1899	59.7	70.3	72.1	70.8	61
1900	58.1	69.2	74.1	73.3	66.1
1901	57.6	69.1	74.7	71.4	63.2

June in 1899, 1900 and 1901 was markedly warmer than in 1897 and 1898 and July in both 1900 and 1901 was warmer than the same month in 1897, 1898 and 1899, and this higher temperature is more marked in August 1900, which is just about the time of year when many insects would respond most readily to the influence of heat, specially those in the caterpillar stage, and the more than normal warmth would tend to produce greater vigor than usual in this latitude and a consequent increase in numbers the present year. The increased warmth of the last two years is still better shown in the table of monthly means of Albany, compiled from the same sources as the preceding table.

Monthly mean temperature of Albany

	May	June	July	August	September
1897	59	65	75	70	63
1898	58.2	69.8	75	73	69.6
1899	60	71	73.2	72.3	61.4
1900	57.9	70.5	74.6	74.7	67.7
1901	59.1	70.2	75.8	72.8	65

It will be seen that June of 1899-1901 was distinctly warmer than in the two preceding years, and, while no other months show as marked difference in mean temperatures, even this means a considerable increase in warmth for the season when accompanied by no corresponding decrease in other months. It is also worthy of notice in this connection that July 1901 was exceptionally warm, as compared with preceding years.

Cicada killer, Sphecius speciosus Drury. This handsome, black, yellow marked wasp has been relatively quite abundant about Albany the last summer. A few specimens were taken in the city and at Karner, 7 miles west, it was abundant about scrub oaks, where it appeared to be feeding on the sap

Fig. 28 Cicada killer (original)

exuding from some of the buds. This insect has previously not been recorded so far north, not being known to occur in the Hudson river valley above the vicinity of Poughkeepsie. Its presence and abundance are probably due largely to the more than normal warmth of the last year or two.

Giant swallowtail or orange dog, Heraclides cresphontes Cram. The larvae of this giant butterfly were unusually abundant last summer. They were sent to the office from Athens, Greene co., Selkirk and Albany, Albany co., Schoharie, Schoharie co., Albion, Orleans co., and Batavia, Genesee co. The report from Batavia states that this insect is something entirely new to that locality. The caterpillars must have been quite abundant at Schoharie, as about 200 were taken from

common "rue" and from fraxinella, and a shrub full of "thousands" of smaller ones was also reported. This caterpillar may attain a length of 2½ inches. It is curiously mottled with shades of brown and with two large silvery white patches, one near the middle of the caterpillar, and the other at its posterior extremity, giving it a peculiar, blotched appearance, and making it resemble somewhat the droppings of a bird. It is well represented, with its reddish, fetid osmeterium extended, as is the case when it is annoyed or alarmed, in the accompanying figure.

The above records are in marked contrast to those of pre-

Fig. 29 Orange dog or caterpillar of Heraclides cresphontes

vious years, the presence of this species in the state having been reported directly to the office but twice before, according to published records, once last year, when our attention was called to its occurrence on fraxinella at Altamont, and again in 1892, when it was sent to the late Dr J. A. Lintner from Glen Cove L. I., with the statement that the caterpillars were numerous on Choisya ternata. Dr Lintner, commenting on this insect in his report for that year,[1] makes the following statement:

Papilo cresphontes is a southern species ranging from the northern part of South America northward. It has gradually extended its range until now it occurs as far north as

[1] N. Y. state ent.. 9th rep't. 1892. p. 337.

Montreal in Canada. The first record of its appearance in the state of New York was in 1864. Within late years, from being an occasional visitor, it seems to have established itself in Westchester county, and at Poughkeepsie. In other localities in the state it is occasionally abundant, as in Rochester, where, according to Mr Bunker, it "swarmed" one season, several years ago. Prof. L. M. Underwood has written me that on Sep. 12, 1882, he saw several examples flying over the low swales near the Rhinebeck and Connecticut railroad in Columbia county. It has not been observed in the neighborhood of Albany. A single example was taken at New Baltimore, 17 miles south of Albany, in the month of September.

Rose scale insect (Aulacaspis rosae Sandb.) This destructive southern species was found June 3 in abundance on blackberry bushes at Hudson N. Y. The young were appearing in considerable numbers at this time. It was breeding in large numbers on cuttings from a crimson rambler rose brought from Cobleskill N. Y. Oct. 18. Adult female scales were abundant and several parasites, Arrhenophagus chionaspidis Aur. were observed crawling on the twigs. This scale insect was also sent in on raspberry plants from Cornwall N. Y. This is a species which is brought to attention at infrequent intervals in this state. One reason for this may be found in its general resemblance to the exceedingly common Chionaspis furfura Fitch, and it is not at all unlikely that many after a glance have concluded that the scale on the raspberry or blackberry was the scurfy bark louse and therefore not pushed the inquiry further. The species is represented on pl. 4, fig. 3, 4.

EXPERIMENTAL WORK AGAINST THE SAN JOSÉ SCALE INSECT

The tests of various insecticides begun last year were continued in the same orchard during the present season, and in the main the results in 1900 were confirmed, and our confidence in a mechanical crude petroleum emulsion much increased. The chief aim of experimental work along this line is to make comparative tests of various insecticides, and naturally some of the substances used are not so effective as one might desire; yet, in spite of that drawback, the experimental orchard is in much

better condition than it was two years ago. It is only necessary to compare pl. 5, 6 to obtain a relative idea of the value of spraying for San José scale. The experimental orchard was the first in that vicinity to become infested with the San José scale; and two years ago it was composed of a very bad-looking lot of young trees. Today the conditions are reversed, so far as these two orchards are concerned, and the later infested, near by orchard is in much worse shape than the other. It is true, that the former is composed of appletrees set a considerable distance apart, and that naturally makes the orchard look thin compared with the more closely set peachtrees and peartrees, but a close examination shows that the true relative condition of the trees is very fairly expressed in the two plates.

The poor results obtained from early spring applications of kerosene and mechanical emulsions of the same in 1900, led to the concentrating of the work on the more promising insecticides, namely, crude petroleum and whale oil soap in various combinations. Two crude petroleums were used, care being taken to make field tests of the oil just before spraying, consequently there can be no doubt regarding its weight as determined by the hydrometer. One of the crude petroleums used was obtained from a local oil dealer handling the products of the Standard oil co. This is a quite fluid, greenish oil, and it gave a field reading of 41.8° Beaumé. It was presumably about the same as that used last year, as it appeared no different and was obtained from the same source. The other crude petroleum was received directly from the Frank oil co., Titusville Pa. This was of a light amber color, and it was said to test from 44° to 45° on the Beaumé oil scale. In the field it gave a reading of 43.3° Beaumé. Both of these tests were made at a temperature of about 65° F. These two crude petroleums, for the sake of brevity, have been characterized in our records as Standard oil and Titusville oil respectively, and these names will be used in the following pages. Comparative tests of mechanical emulsions of both these oils were made, and the results are given below. The spraying was done April 11, which was bright, with at times a rather strong wind.

Substances experimented with. Crude petroleum was tested on a large number of trees, both the Standard and the Titusville oils being used in 20% and 25% mechanical emulsions, and the latter was also used undiluted on a few trees. Good's whale oil soap no. 3 in a solution of 1 pound to 4 gallons of water was used with 10% and 15% Standard oil, the kerowater sprayer being employed, as last year, in making a mechanical combination between the soap solution and the oil. Good's whale oil soap was also used by itself at the rate of 2 and of 1½ pounds to the gallon.

Time and methods. The apparatus, the hand kerowater spraying outfit, was the same as employed last year. The experiments were all in the same orchard, for a diagram of which the reader is referred to pl. 3 of the preceding report. It was undesirable to treat all the trees with the substances used on them in 1900; and it will be seen by consulting the diagram, that the different insecticides have been applied to transverse sections of the orchard. This did not always permit of applying the same preparation to several varieties of pears and peaches, but, on the other hand, it was much easier to keep track of different tests. The numbers bestowed on the trees in 1900 have been retained, and it is thus very easy to ascertain the previous history of any tree by consulting the preceding report.

Supplementary notes. There are several observations which, though not strictly a part of the experimental work proper, may as well be recorded in connection with it, since they were noted in the progress of the work. The young of the San José scale were abundant on trees in the experimental orchard July 3, 1901, and, as there were a number of young in the black stage, they must have begun to appear about a week before. Sep. 25, young were crawling in considerable numbers on relatively few trees, and the same condition was observed Oct. 15. Thus this period agrees with those observed in preceding years, and the breeding season may be said to extend from the latter part of June through October.

There is a brief mention of the occurrence of the little black ladybug, Pentilia misella Lec., in my previous report,[1] but this year it was observed in much larger numbers on infested trees in the experimental orchard and also in an infested orchard near by. It was much more abundant in the latter, probably on account of the much larger number of scale insects, since practically nothing had been done to keep the pests in check. This beneficial form was not present in sufficient numbers to attract notice till Sep. 25, and from then till the middle of October, at least, the beetles were quite numerous; 50 on a small badly infested tree would not be an excessive estimate. These ladybugs, however, do not seem to have made much impression as yet on the San José scale; and, though they were much more abundant in the adjacent orchard where no insecticides of any account had been applied, the scale had not been affected enough to warrant a hope that eventually this pest may be controlled by this little natural enemy. It certainly would not be wise at present to defer treatment with insecticides on account of the presence of this tiny ladybug.

The fruit tree bark beetle, Scolytus rugulosus Ratz., also occurs in the experimental orchard, attacking a number of trees last year but injuring only one very seriously. This was broken down by wind or other agency, and the beetles entered the prostrate limbs in large numbers. This year a light oxheart cherry (tree 4) was attacked by this beetle and injured considerably. It was in excellent condition last year, but toward the end of the season became rather badly infested with San José scale. July 3 it was found to be infested with Scolytus. There was a copious exudation of sap or gum and a number of edematous swellings were observed here and there. The tree was quite badly affected Aug. 9. Several other trees were attacked to a less extent by this borer.

Appearance of oil on trees. This general note applies to all trees treated with crude petroleum or mechanical emulsions of the same. May 22, the oil shows very plainly, and all of the

[1] N. Y. state ent. 16th rep't. 1901. p. 970.

trees appear to have been in a very good condition, except where dead twigs are recorded in the following notes, and this is more likely due to injury by the San José scale or winterkilling from some other cause, than from the application of insecticides, either this or the previous year; since it is about as common on trees treated with whale oil soap as on those sprayed with crude petroleum.

Standard oil, 20% mechanical emulsion. 11 trees were treated with this combination. They are as follows: tree 115 a Bartlett and trees 24, 110 and 111, Kieffer pear; tree 25, a beurre bosc; trees 70 and 71, respectively Clapp's favorite and beurre d'Anjou pears; trees 43, 44, 88 and 89, old Mixon peach. The condition of these trees was as follows toward the close of the growing season, Sep. 7, 1900. There were very few or no young scale insects on trees 24 and 115; no living young were found at that time on tree 111, very few on tree 110, but few on trees 25, 43 and 44; living young were very abundant on trees 70, 71 and 88, specially on tree 71, and they were extremely abundant on tree 89.

The first observations, made after the spraying of Ap. 11, were on May 22, when only those trees presenting something out of the ordinary received special attention. Tree 71 had then only one vigorous shoot, and tree 88 had been cut down to a five foot stump, from which a few buds were breaking forth.

July 3, a date which was late enough to permit a fair judgment of the numbers of living scale insects, through the abundance of the young, the conditions were as follows. There were few or no young on trees 24, 25, 43, 88, 110, 111 and 115; young were rather few on tree 44 and few on trees 70, 71 and 89. The following additional notes were made at this time regarding the condition of certain of the trees. The new shoots on tree 25 were vigorous, and the cluster of shoots on tree 88 were short and vigorous. The bark of tree 70 was very rough.

Aug. 9 very few or no young scale insects were to be found on any of these trees. The shoots on tree 88 were growing very fast.

Sep. 25, there were very few or no young scale insects on trees 24, 25, 71, 88, 89, 110 and 111; and young were relatively few on trees 70 and 115.

The above record, it will be observed, shows that with only one application in a year, the San José scale was kept in control in a very satisfactory manner, with the exception, perhaps, of trees 70 and 115. The former was very badly infested in the spring of 1900, and, while the treatment with whale oil soap controlled the pest to a great extent, living young were very abundant on it in September 1900. Its bark was very rough, and this with the old scales would serve as a considerable protection to the young, and it is not surprising that some survived the spraying of 1901. It is by far the worst tree in this lot. Tree 115 is exceptional in that it was located on the edge of an old orchard, where it could become infested from neighboring trees.

Standard oil, 25% mechanical emulsion. 7 trees were treated with this mixture. They are as follows: tree 21, a Howell, and tree 106, a Vermont beauty pear; trees 38, 83 and 84, globe peach; tree 40, a Crawford and tree 85, an old Mixon peach. The condition of these trees toward the close of the growing season, Sep. 7, 1900, was as follows. Young scale insects were very few on trees 83 and 84, few on trees 85 and 106, abundant on tree 21, very abundant on tree 38, and exceedingly so on tree 40. Trees 39, 66, 67 and 107 also belonged in the area treated with this mixture, but all of them were cut back to mere stumps in 1900, and they were removed in the spring of 1901.

May 22 the following notes were made on trees presenting an appearance out of the ordinary. There were only a few small limbs alive on tree 40, and a number of small limbs had been winterkilled on tree 83. Tree 106 was thickly set with fruit.

July 3, the following conditions were apparent. There were very few or no young scale insects on trees 38, 40, 83, 84 and 106; they were few on tree 21, and rather abundant on tree 85. It was noted that the bark was quite rough on trees 21 and 66, which undoubtedly explains why young scale insects were present on these trees, as it is practically impossible to kill all the

individuals with a spray when the bark offers numerous sheltering crevices.

Aug. 9 there were few or no young scale insects on trees 38, 40, 83, 85 and 106, few on trees 21 and 84, and rather few on tree 66.

Sep. 25, the following conditions prevailed. There were very few or no living scale insects on trees 83 and 106, very few on trees 84 and 85, few on trees 38 and 40. Young scale insects were rather abundant on some twigs of tree 21, but its general condition was very good considering its previous history.

This record is apparently not so satisfactory as in the case of the smaller per cent of oil. Allowance should be made in the case of trees 21, 38 and 40. The first was in exceedingly bad shape in the spring of 1900, and, while spraying with undiluted kerosene killed many of the scales, so many were left that the tree was abundantly infested the following September. The scraggy, rough condition of the tree, in my opinion, amply accounts for the failure to kill all the scale insects last spring. Trees 38 and 40 were sprayed with 20% kerosene in 1900, and the abundant scales on them in the spring of 1901, together with the very rough bark of tree 38, would afford ample shelters for the escape of a few. The very few living scales found on trees 84 and 85 in September 1901 could easily have been brought from adjacent trees, though one or two individuals may have escaped the spray.

Titusville oil, 20% mechanical emulsion. There were 14 trees treated with this mixture. They are as follows: trees 26 and 27, Kieffer; trees 28 and 114, seckel; tree 72, Flemish beauty; tree 73, Howell; tree 74, beurre bosc; trees 112 and 113, beurre d'Anjou pears; trees 45, 47, 90 and 91, old Mixon peach; and tree 46 a champion quince. Their condition near the end of the growing season, Sep. 7, 1900, was as follows. There were few or no young scale insects on trees 26, 27, 112, 113, few on trees 45, 46, 74 and 114; they were rather abundant on trees 47 and 73, abundant on tree 28, and very abundant on trees 90 and 91.

The first examination after spraying occurred May 22, and only those trees presenting something out of the ordinary were

noted. Many small limbs were dead, probably winterkilled, on trees 47, 90 and 114. A large dead limb had been cut off of tree 45, the tops of trees 47 and 90 were thin, and all that remained of tree 72 was a stub with vigorous suckers.

July 3, the following conditions were noted. There were very few or no young scale insects on trees 26, 27, 46, 47, 72, 90 and 113; very few young were found on trees 74, 112 and 114; few young were found on tree 28; young were rather abundant on tree 45, and abundant on tree 73. At this time the sprouts on tree 72 were growing slowly.

Aug. 9, the conditions were as follows. There were very few or no young on trees 26, 27, 45, 46, 47, 74, 90, 91, 112, 113 and 114; young were rather abundant on tree 28, and abundant on tree 73. Tree 72 was represented only by a stub at this time.

Sep. 25, the following conditions prevailed. There were few or no living scale insects on trees 26, 27, 46, 47, 91 and 113; there were very few on tree 28; few on trees 45, 72 and 90; relatively few on trees 74, 112 and 114; and they were very abundant on tree 73.

The condition of this lot of trees Sep. 25 was fairly satisfactory if we except tree 73, and the occurrence of abundant young on this can be explained only by the probability of a number of insects being so sheltered by the very rough bark that the spring application of petroleum did not reach them. The presence of a few scale insects at the end of the season on trees 45, 72 and 90 is not surprising, considering that they could have easily become infested from other trees, even if all the living scale insects on them at the time of the treatment had been killed by the petroleum. The occurrence of more living scales on trees 74, 112 and 114, all of them located on the extreme edges of the orchard and in positions where they would be most likely to have the pest carried to them by birds and other insects, gives additional weight to the opinion that the results produced by the various insecticides have been modified during the growing season by the conveying of crawling young scale insects to the trees by various natural agents. A very

good proportion of the trees in this lot are practically free from San José scale.

Titusville oil, 25% mechanical emulsion. There were 10 trees treated with this mixture. They are as follows: trees 22, 23 and 69, Howell; tree 68, a Vermont beauty; tree 108, a Bartlett; tree 109, a beurre bosc pear; trees 41 and 86, Crawford; and trees 42 and 87, old Mixon peach. Their condition near the end of the growing season, Sep. 7, 1900, was as follows. There were very few or no young scale insects on tree 86; few on trees 42 and 109; they were rather abundant on trees 41 and 87; abundant on trees 22, 23, 69 and 108, and exceedingly abundant on tree 68.

May 22, there were only a few upper limbs living on trees 86 and 87.

July 3, there were very few or no young scale insects on trees 41, 42, 86, 87 and 109; there were few on trees 22 and 69; they were rather abundant on tree 23, and abundant on trees 68 and 108.

Aug. 9, there were very few or no young on trees 41, 42, 87 and 109; and they were rather abundant on trees 23, 68, 69 and 108. Tree 86 was dead.

Sep. 25, there were very few or no young on trees 69, 87 and 109, few on trees 41 and 42, rather few on trees 23 and 108; and they were rather abundant on trees 22 and 68. Tree 87 was then a mere stump.

A study of the above record in connection with the diagram of the orchard shows that, of the six trees on which living San José scales were found Sep. 25, three were on the extreme edges of the orchard and therefore very liable to become reinfested during the season. In addition, it should be noted that two of these three trees, nos. 22 and 23, were very badly infested in the spring of 1900, and in the fall of that year living scale insects were abundant on them. The bark on these trees was also very rough. Of the other three, there were only a few living scales on trees 41 and 42, and the remaining interior tree, no. 68, which has a very rough bark, was very badly

infested in the spring of 1900 and abundantly so the following autumn. This is certainly not a very bad showing for this oil.

Crude petroleum, undiluted Titusville oil. The disastrous results obtained with this substance last year acted as a check to more extensive experiments this season. It was decided to test in a small way some of the crude petroleum received from Titusville Pa., because, according to certain published accounts, it would not harm the trees. A description of its physical properties is given on p. 762. Three trees were sprayed with this substance. Tree 20, a Bartlett pear, was very badly infested with the scale in 1900, and it was selected among others, for treatment that spring with undiluted kerosene. It was in a very bad state to begin with, and last October even the suckers from this tree appeared to be in an unhealthy condition. It was sprayed Ap. 11, 1901, with this crude petroleum. It developed no leaves the present season, and it was probably nearly dead before the petroleum was applied. Tree 116 was a Lombard plum which was very badly infested with the San José scale, but, as the infestation was comparatively recent, and as the tree had received no previous application of an insecticide, it was a very good subject to experiment on. The oil was sprayed on the tree rather liberally Ap. 11, and July 3 it was seen that several limbs were seriously injured and dying, and that some of the others gave indications of feebleness. Aug. 9, this tree was dead, the result, undoubtedly, of the application of the oil. Less oil would probably have been less injurious, but the fact remains that this so called safe oil is not necessarily so. The third tree was Crawford peach, which was very badly infested with San José scale, and, like the preceding, it had not been treated with any insecticide. The scales were so abundant as literally to cover most of the trunk and the larger limbs, and in some places they appeared to be two or three deep. This tree developed no leaves, and it was probably very seriously injured by the scale infestation. Its death can hardly be attributed to the application of the oil.

Good's whale oil soap no. 3 and 10% petroleum. The Standard oil was used in these experiments. There were 12 trees treated

with this compound. They are as follows: trees 18 and 63 are an early unnamed pear; trees 19, 64, 65, 104 and 105 are Bartletts; tree 103 is an Idaho pear; trees 36, 37, 81 and 82 are globe peach. The condition of these trees near the end of the growing season, Sep. 7, 1900, was as follows: there were very few or no young scale insects on trees 18, 19, 82 and 104, very few on trees 63, 81 and 105, few on tree 103; they were abundant on tree 36, and very abundant on trees 37, 64 and 65.

May 22 it was seen that many of the tips of the smaller limbs on tree 37 had been winterkilled, and that tree 82 had suffered in this way to some extent.

July 3, there were very few or no young scale insects on trees 36, 81, 82, 103, 104 and 105, few on trees 18, 19, 37, 63 and 65; and they were rather abundant on tree 64, which has a rough bark.

Aug. 9, there were few or no young on trees 18, 36, 37, 63, 81, 82, 103 and 104, few on trees 19, 64 and 105, and they were rather few on tree 65.

Sep. 25, there were very few or no living scale insects on trees 63, 64, 65, 81, 104 and 105, very few on trees 18, 19 and 103, and but few on trees 36, 37 and 82.

The record for this substance is very good. Three of the trees having very few living scale insects on them at the end of the season were on the edges of the experimental orchard, where they could easily have become reinfested. Living scale insects were abundant and very abundant, respectively, on trees 36 and 37, while tree 82 was very badly infested in the spring of 1900, and, though very few were found on it at the end of that season, some might easily have escaped the second treatment under the shelter of old scales.

Good's whale oil soap no. 3 and 15% petroleum. The Standard oil was used in these experiments. This combination was tested on 13 trees. They are as follows. Trees 15, 16, 60, 61 and 101 are seckel; trees 17 and 62, an early unnamed variety, and tree 102, a beurre bosc pear. Trees 34, 35, 79 and 80 are globe peach trees; tree 34a, a natural sprout. Their condition near the end

of the growing season, Sep. 7, 1900, was as follows. There were very few or no young insects on trees 60, 61, 79, 101 and 102, very few on tree 80, few on trees 16, 17 and 62; they were rather abundant on trees 34, 35, and numerous on tree 15.

May 22, very few limbs were winterkilled on trees 34, 35 and 80, and there were a number of dead limbs on tree 101.

July 6, there were very few or no young scale insects on trees 34, 34a, 62, 80, 101 and 102, very few on trees 17, 35, and 79, few on trees 16 and 60; they were rather abundant on tree 15, and abundant on tree 61. The bark of tree 61 was very rough, and the sprouts on tree 101 were rather thrifty.

Aug. 9, there were few or no young on trees 17, 34, 34a, 35, 60, 62, 79, 80, 101 and 102; they were rather abundant on trees 15, 16 and 61.

Sep. 25, there were few or no living scale insects on trees 34, 62 and 101, very few on trees 15, 16, 17 and 102, few on trees 34a, 35, 60, 79 and 80; they were rather abundant on tree 61.

The general condition of this lot of trees Sep. 25, 1901, is very fair. Living insects were found on three quarters of the total number, but not in considerable numbers, except in the case of tree 61, which was very badly infested in the spring of 1900, and its rough bark undoubtedly accounts to a large extent for the poor success in controlling the pest in this instance. The very few on trees 15, 16, 17 and 102 might easily have been carried to them by natural agents, since they are on the edge of the orchard near adjacent, untreated trees. In the case of the remaining infested trees, nos. 35, 60, 79 and 80, while they may have been reinfested, it is very probable that in each instance a few insects escaped the spray.

Good's whale oil soap, no. 3, 1½ pounds to the gallon. This strength was used on 24 trees. They are as follows. Tree 3 is a light oxheart, tree 4, a wild cherry, and tree 4a, a plum 5 feet high. Tree 6 is a Crataegus. Tree 75 is a Crawford, and tree 29 is a globe peach. Trees 7, 9, 51, 52, 53 and 92 are botan; tree 8 is a Lombard; tree 49, an abundance, and tree 95, a golden drop plum. Tree 54 is a nectarine. Trees 10 and 55 are beurre

bosc; trees 11, 56 and 57 are seckel; tree 50, an Idaho, and tree 96 a beurre d'Anjou pear. Tree 48 is a crab apple. The condition of these trees near the close of the growing season, Sep. 7, 1900, was as follows. There were very few or no living scale insects on trees 5, 6, 29, 48, 49, 55 and 56, very few on trees 75 and 97, few on trees 7, 30 and 96; they were very abundant on trees 3 and 50 to 53, and extremely abundant on trees 8 to 11.

May 22, tree 5 was just beginning to bloom, though it had been partly uprooted by the wind. Trees 9 and 10 had set considerable fruit. Trees 52 and 53 were winterkilled to some extent, and the same was true of tree 92. Trees 93 and 94 had died from the applications of the previous year, and had been removed.

July 6, there were very few or no young scale insects on trees 4a, 7, 7a, 11, 29, 30, 48, 55, 75, 96 and 97, few on trees 51 and 56; they were rather abundant on trees 4, 9, 10, 52, 53, 92 and 95, and very abundant on trees 8 and 50. There was considerable dead wood on trees 52, 53 and 92, and the bark was rather rough, affording admirable shelters for scale insects. Tree 8 was very badly infested in the spring, and the bark was quite rough. The same was practically true of tree 10. Tree 4 had been attacked by Scolytus rugulosus Ratz., and the sap was exuding copiously.

Aug. 9, there were very few or no living young scale insects on trees 6, 7, 29, 30, 48, 55, 56, 96 and 97, few on trees 4, 4a, 7a and 9, trees 8, 49, 51, 52, 53 and 92, abundant on tree 95, and very abundant on tree 50. Tree 5 had been removed, it probably dying as a result of being partly uprooted.

Sep. 25, there were few or no living scales on trees 6, 55, 56, 96 and 97, few on trees 10, 29, 30, 48, 54, 55 and 75, rather few on trees 4a, 49 and 51; they were rather abundant on trees 4, 7, 7a, 9, 11, 52 and 95, and very abundant on trees 8 and 50. Tree 75 was broken down to the trunk by a heavy crop of fruit, but the semiprostrate limbs showed no evidence of having been attacked by Scolytus rugulosus Ratz. There was a large amount of dead wood on tree 92, and many vigorous shoots. Scolytus was working in the dead wood and also attacking the living to some extent.

The record is about on a par with that of the stronger solution of whale oil soap. The scale has been held in check in most instances, but there is no approach to exterminative work, such as is effected by the mechanical emulsions of crude petroleum. There are comparatively few extenuating circumstances, since only five trees in this large lot were abundantly infested with the scale in the fall of 1900, and, as this condition was due to recent development, the bark of these trees was hardly rough enough to insure much protection to the scales.

Good's whale oil soap no. 3, 2 pounds to the gallon. This solution was tried on 15 trees. They are as follows. Trees 12–14, 57–59 and 98–100 are seckel pear; trees 31–33 and 76–78 are globe peach. Their condition about the close of the growing season, Sep. 7, 1900, was as follows. There were very few or no young scale insects on trees 57 and 78, very few on trees 76, 77 and 98, few on trees 31, 99 and 100; they were rather abundant on trees 58 and 59, abundant on trees 32 and 33, and extremely abundant on trees 12–14.

May 22, tree 100 had set considerable fruit; trees 31, 32 and 77 were injured somewhat by winterkilling, the tips of many of the smaller limbs being dead; tree 76 was also badly affected in this manner.

July 6, there were very few or no young scale insects on trees 31, 32, 57, 76, 77, 78, 98 and 100, few on trees 33, 59 and 99, and rather few on tree 58; they were rather abundant on tree 14, abundant on tree 12, and very abundant on tree 13. The bark of both trees 58 and 59 is quite rough.

Aug. 9, there are very few or no young on trees 31, 32, 33, 57, 76, 77, 78, 98 and 100, and few on tree 59; they were rather abundant on trees 13, 14, 58 and 99, and abundant on tree 12.

Sep. 25, there were few or no living scale insects on trees 57, 98 and 100, few on trees 76 and 78; they were rather abundant on trees 31, 32, 33, 58, 59 and 99, abundant on trees 13, 14 and 77, and very abundant on tree 12.

The record given above is not very bright, particularly when we remember that in this lot there were no very badly infested

trees till the autumn of 1900, when trees 12, 13 and 14 were very badly infested; and, on account of this close proximity to trees in a similar condition on which the scale bred unchecked during the entire season of 1900, it is very probable that they became reinfested during the growing season, and therefore their condition Sep. 25, 1901, should not be taken into account when judging of the merits of whale oil soap; and the same would be true, but to a less extent, of trees 31–33. Even after throwing these trees out of consideration, the results are not equal to those obtained with mechanical petroleum emulsions, though the pest was well controlled.

Summary of experiments

A study of the above records will show that the best results have been obtained with either a 20% or a 25% mechanical emulsion of crude petroleum. Apparently somewhat better results were obtained by the use of the oil purchased from the Standard oil co., but this may be partly accidental. It is a trifle early to be positive regarding this point. It is certain, however, that either the Standard oil or the crude petroleum obtained from the Frank oil co., Titusville Pa., will give very satisfactory results. The whale oil soap and crude petroleum combinations were very effective, but were not so valuable as insecticides as mechanical petroleum emulsions. None of these preparations injured the trees in the slightest degree.

The experiments with the whale oil soap solutions show that, while this substance is valuable as a check, it can hardly be relied on when applied in early spring to do anywhere near so thorough work as the crude petroleum emulsions. The reason for the greater efficiency of the crude petroleum is probably found in the greater penetrative action of the oil. The few tests with the undiluted crude petroleum confirm the experience of the previous year and lead us to conclude that it is a very unsafe substance to apply to trees.

VOLUNTARY ENTOMOLOGIC SERVICE OF NEW YORK STATE

The work of the last two years has been continued, and a large number of observations have been added to previous records. 39 voluntary observers were appointed during the season, and 35 of them have rendered more or less detailed reports. The summaries of these reports, representing as they do, the entomologic conditions in 33 counties, are given below.

Very naturally, owing to the great destructiveness of the forest tent-caterpillar, Clisiocampa disstria, and its close ally, the appletree tent-caterpillar, Clisiocampa americana, many of the reports dwell much on these two insects. The Hessian fly, Cecidomyia destructor, has also received considerable attention at the hands of the voluntary observers.

Summaries of reports from voluntary observers

The scientific names or other matter inserted in brackets indicate determinations or information supplied by the entomologist. The other names are presumably correct, except where questioned. The dates given after the records are those of the reception of the reports, and they are usually from one to three days later than the writing of the report.

Albany county (E. T. Schoonmaker, Cedar Hill)—Forest tent-caterpillars [Clisiocampa disstria] are hatching out in large numbers, and the prospects are that they will be more numerous than last year. Ap. 30. They are eating in the center of the leaf buds and thus making their control exceptionally difficult, though the cold weather of the past week has caused them to remain comparatively inactive up to this date. May 5. Elm leaf beetles [Galerucella luteola] have appeared in limited numbers, though many still remain in buildings. The forest tent-caterpillars are quite abundant on maples, and their ravages are now quite noticeable. Heavy rains have checked their ravages to some extent, but conditions are not favorable for their wholesale destruction. May 21. Striped cucumber beetles [Diabrotica vittata], squash bugs

[Anasa tristis] and crickets are rather few. Young grasshoppers are numerous and are appearing on potatoes and other garden crops. Potato beetles [Doryphora 10-lineata] are very numerous and destructive. Elm leaf beetle grubs are more numerous than last year and are growing very rapidly. Tent-caterpillars have spun their cocoons. The recent rains have caused the disappearance of plant lice on rosebushes and trees. July 9. Elm leaf beetles are now in the pupa stage, and their ravages are equal to those of last year. Striped blister beetles [Epicauta vittata] are exceptionally numerous defoliating many potato patches. A thorough spraying with a strong solution of arsenate of lead has proved very satisfactory. Grasshoppers are more abundant than last year, and quail are devouring them in large quantities. Squash bugs are very numerous and destructive, and many melon patches have been ruined by their ravages. Cabbage butterflies [Pieris rapae] have appeared in small numbers. Spotted grapevine beetles are numerous, and they are doing much damage to grape leaves. Codling moth injury is as great as in former years. July 30.

Chemung county (M. H. Beckwith, Elmira)—[Lecanium cerasifex] is quite abundant on an appletree in my orchard. Mar. 26. Appletree tent-caterpillars [Clisiocampa americana] appeared for the first time Ap. 29. They are much more abundant than last season. May 13. Currant worms [Pteronus ribesii] appeared on gooseberries on May 31, and the first potato beetle [Doryphora 10-lineata] was seen May 21. May beetles [Lachnosterna] are very abundant. May 23. Injury by Hessian fly [Cecidomyia destructor] is very evident in several fields of wheat which I examined today. Probably 10% of the stalks have fallen down on account of the work of the fly. June 29.

Dutchess county (W. F. Taber, Poughkeepsie)—Appletree tent-caterpillars [Clisiocampa americana] are very abundant in many orchards and will probably do much damage if they are not looked after. Heavy rains and cool weather have kept insects in check. May 21.

(H. D. Lewis, Annandale)—The egg masses of both the forest and appletree tent-caterpillars [Clisiocampa americana, C. disstria] are very numerous, and the indications are that these pests will be very destructive. Appletree bark lice [Mytilaspis pomorum] and scurfy bark lice [Chionaspis furfura] are very abundant in this section. Ap. 13. Tent-caterpillars appeared in large quantities from Ap. 25 to May 1, and the forest tent-caterpillars were very numerous about a week later. Both species will be fully as abundant as last year, though the cool wet weather has held them somewhat in check. May 18. Forest tent-caterpillars are more abundant than ever before. Some orchard and shade trees are being completely defoliated by them. The common appletree tent-caterpillar, though numerous. does not appear to be so abundant as last year. The rains have been so frequent that it has been very difficult to keep insecticides on the trees, and consequently these pests are not controlled even by the most careful growers. May 24. There are large numbers of tent-caterpillars of both species. Cutworms are very numerous, and there are some plant lice of different species. The continuous rains have made it very difficult to keep the immense numbers of forest tent-caterpillars under control. June 1. Potato beetles [Doryphora 10-lineata] are just appearing in considerable numbers. Tent-caterpillars are beginning to spin their cocoons, after having caused more injury than ever before. I have noticed robins picking open the cocoons and devouring their contents. Striped squash beetles [Diabrotica vittata] are quite abundant. Injury by the plum curculio [Conotrachelus nenuphar] is apparently much less than for many years. June 17. Fall webworms [Hyphantria cunea] are just making their appearance. Potato beetles are more abundant than they have been for years. June 29. Trees that were defoliated by tent-caterpillars have developed new foliage. Many of the cocoons of the forest tent-caterpillar appear dead and shriveled, but no moths have been seen in this vicinity. July 19. Red-humped appletree worms

[Schizura concinna] are present in small numbers and confined to two or three orchards. The eggs of the appletree tent-caterpillar occur in large numbers, but I fail to find any of the forest tent-caterpillar. Aug. 12. A small webworm, Cacoecia species, is doing a great deal of damage to maples. Aug. 20.

Erie county (M. F. Adams, Buffalo)—Mourning cloak butterflies [Euvanessa antiopa] were flying Ap. 11, and red admirals [Vanessa atalanta] were flying the 13th. The egg masses of the white marked tussock moth [Notolophus leucostigma] are abundant in many localities, and their ravages will probably equal those of 1895. May 10. The young grubs of the willow snout beetle [Cryptorhynchus lapathi] were found abundant in Carolina poplars just beneath the bark. The mines are irregular, winding and extend upward. Goes pulchra is destroying young hickory. May 21. May 19, Saperda fayi had pupated. May 20 the males of the Putnam scale [Aspidiotus ancylus] were emerging. The euonymus scale [Chionaspis euonymi] is quite injurious in this section. May 25. Carpenter worms [Prionoxystus robiniae] were found in the larva and pupa stages in the ash, and to all appearances those which were to emerge this year had already pupated. May 29. June 5 I took adults of Podosesia syringae ovipositing in Fraxinus excelsior and on the same date adults of Neoclytus erythrocephalus were emerging from a dead tree of the same species. The appearances indicate that there will be an unusually large number of the locust borers this season. June 7. Observation in the near vicinity of Buffalo shows that from 6% to 8% of the wheat has been destroyed by Hessian fly [Cecidomyia destructor]. June 11. Graphisurus fasciatus, Xyloterus colonus and Typocerus zebratus have been emerging from Quercus rubra, the first on the 18th and the latter two June 14. Saperda fayi also emerged on the latter date from various species of Crataegus. The willow snout beetle was ovipositing on cotton

woods June 16. Moths of the carpenter worm emerged from ash and poplar June 14. June 19. The cool weather of the spring has apparently kept the white marked tussock moth in check, as the caterpillars are now not over ¼ of an inch in length, while last year on this date many of them were full grown and had commenced to spin their cocoons. June 28. July 4 white marked tussock moth caterpillars were spinning their cocoons in the down town districts. A few have been destroyed by a bacterial disease. July 5. June 28 the last locust borer moth emerged from the the wood. July 17 the female white marked tussock moths were depositing their eggs, and on the same date I obtained examples of the willow snout beetle from the balm of Gilead in the adult larval and pupal stages. The 15 spotted ladybug [Hippodamia 15-punctata] has been exceptionally abundant this season and has proved itself a valuable ally in destroying plant lice. The white marked tussock moth has been quite injurious in many localities in the city, and in some places it was as destructive as in 1895 or in 1898. Parasites appear to be rather scarce. The willow snout beetle is still causing a great deal of injury to poplars and willows in this vicinity. I have taken it from the following varieties: balsam poplar, balm of Gilead, Carolina poplar, Lombardy poplar, Babylonian willow, heart-leafed willow, Kilmarnock willow and from the trunk of the new American weeping willow. I have never taken it from the golden-barked willow, laurel-leaved willow, the silver poplar, the bollean poplar, though a great many of these varieties are growing in the vicinity of the infested trees. July 26.

(J. U. Metz, East Amherst)—The common asparagus beetle [Crioceris asparagi] has appeared for the first time this year. May 20. Hessian fly [Cecidomyia destructor] is present in great abundance, and many fields of white wheat are not worth cutting. I have counted as many as 20 "flaxseeds" in a single stalk. There is apparently no difference between early or late sown wheat. Red Russian and red Mediterranean seem to be exempt thus far from attack. A few

appletree tent-caterpillars [Clisiocampa americana] are seen on wild cherry. July 2. The work of the Hessian fly is becoming more apparent as harvest time approaches, and nearly every stem of wheat is infested. I have an idea that the wheat will yield better than some people surmise at present. I have just been examining my asparagus and have been unable to find any beetles or slugs. Plum curculios [Conotrachelus nenuphar] seem to be worse than usual this year. White grubs or something of that nature must be working in my sheep pasture, as much of the grass is pulled up by the sheep. It seems to be cut off below the surface of the ground by some insect. July 16. Grasshoppers are now very numerous, and my crop of celery for home use has been destroyed by them. July 20.

Fulton county (Cyrus Crosby, Cranberry Creek)—Appletree tent-caterpillars [Clisiocampa americana] do not appear to be very abundant, as I have seen but one nest on an appletree so far this year. Appletrees in this vicinity are nearly all badly infested with the appletree bark louse [Mytilaspis pomorum]. May 8. The cold damp weather has checked the development of insects very much. The nests of the appletree tent-caterpillars are beginning to show up, but they are by no means as thick as they were in Yates county last year. May 17. I find little beetles [Typophorus canellus, a strawberry root worm] on elms. They were very common two weeks ago. June 6. There are a few appletree tent-caterpillars near Mayfield, but elsewhere I have seen none. Only one forest tent-caterpillar [Clisiocampa disstria] was found. Horn flies [Haematobia serrata] are very troublesome to cattle. June 22.

Genesee county (J. F. Rose, South Byron)—Appletree tent-caterpillars' eggs [Clisiocampa americana] began hatching about Ap. 25, and they are now very numerous. One cold day I climbed into a tree for the purpose of crushing the caterpillars in a nest. It was an ideal day for them to be at home, but I found they were scattered for a distance of 2 feet

or more from the nests and were destroying the leaves at a rapid rate. May 10. Colorado potato beetles [Doryphora 10-lineata] are now seen in numbers in gardens, and, as potatoes are not up, the beetles are working on transplanted tomatoes. Early sown turnips and cabbages suffer severely from the cabbage maggot [Phorbia brassicae]. Canker worms are doing great damage in orchards where they were numerous last season. The roadside shrubbery is about defoliated by appletree tent-caterpillars. The sugar maple borer [Plagionotus speciosus] is doing considerable damage in this vicinity. Its work in various trees shows first in dead limbs 40 to 60 feet from the ground, and this renders its control practically impossible. The red wheat, where that has been sown, has suffered very little injury, perhaps 5% to 20%. June 11. A large crop of what early promised to be good wheat will not be worth cutting on account of the Hessian fly [Cecidomyia destructor] injury. Some farmers are plowing up their injured wheat fields and sowing them with other crops, though many will not, as they are anxious to save the seed. Many full grown tent-caterpillars were crawling about the streets June 1 looking for places to spin up. Potato beetles, asparagus beetles [Crioceris asparagi] and striped cucumber beetles [Diabrotica vittata] are present in usual numbers. Currant worms [Pteronus ribesii] are scarce. June 6. I am unable to learn of any white wheat that is not badly injured by the Hessian fly. The red wheat has not been injured to any extent as yet. June beetles have been exceptionally scarce, and cutworms are more than usually abundant. The cabbage maggot has never been so injurious. It took one fourth to one third of 200 early cabbages. Colorado potato beetles are exceptionally abundant on early potatoes. On vines 6 to 8 inches high, which were sprayed with bordeaux mixture and arsenoid, the beetles were pretty thick, and examination showed that they had been cutting off the leaves and eating into the stems of the plants. Both sweet and sour cherries have been nearly ruined by the

cherry aphis [Myzus cerasi] and the new growth of plums and prunes is a solid mass of grayish green plant lice. Reports are coming in that some insect [? Phorbia fusciceps] is seriously injuring beans. June 25. Very little, if any, white wheat will be harvested in this section. 90% of all that is grown in this section is a white wheat known as no. 6. It has been exclusively grown for some years and is a fine yielder. The prospect early in the season was that there would be 20 to 35 bushels to the acre in all fields, as there was little winter injury. A field of white wheat near here, belonging to G. G. Chick, was not sown till the first week in October and looked well much later in May than that early sown, but today he informs me that there will be no wheat. July 2. An eight acre field of white beans, which had been sown on a field of ruined wheat, was found to be seriously infested with some insect. The beans at the time of the examination were 3 to 4 inches high, and there were long spaces in the rows where no plants could be seen at all, and in many other places there were only bare stems with no signs of leaves. [This injury was subsequently identified as probably the work of a small fly, Phorbia fusciceps]. The Hessian fly has also attacked rye, timothy and barley. A perfectly reliable farmer has told me that he has found as many as 50 of the fly maggots in a stalk of barley. One of our large farmers is now cutting his barley and curing it for hay, it is so badly affected. I saw yesterday in Leroy some wheat which is known as Golden chaff or Clausen's Golden chaff. It is a white wheat which appears to be but little troubled by the fly, no more than the red wheat about here. July 9. The pale striped flea beetle [Systena taeniata] is quite abundant in some bean fields. July 15. Fall webworms [Hyphantria cunea] appeared for the first time last week. The common squash bug [Anasa tristis] is the worst I have ever known it to be. July 27. Tonight a lot of bean plants that have been eaten off or nearly so, so that they fall over and wilt, were brought to me with the statement that the trouble occurred in a number of fields.

No sign of insect injury was observed in the field. The beans are now about 6 inches in hight, and many of them have buds 3 or 4 inches long. [The trouble was referred to the work of a small fly Phorbia fusciceps]. Aug. 2.

Greene county (O. Q. Flint, Athens)—It is the impression in the western part of the county that the forest tent-caterpillar [Clisiocampa disstria] will be much less abundant than in previous years. Ap. 25. Both the forest tent-caterpillar and the appletree tent-caterpillar [Clisiocampa americana] have hatched, and are much more numerous than heretofore in the eastern part of the county, though not so abundant in the western part as when they first appeared in destructive numbers. The forest tent-caterpillars have been exceptionally injurious in the eastern and east-central parts of the county, defoliating appletrees in particular. The same is true in the western portion of Columbia county. The numbers of this pest are much decreased in the western part of Greene county and in Otsego county. The continuous wet weather appears to have retarded the development of the tent-caterpillars. June 5. The forest tent-caterpillars appear to have done the greatest injury, when present in a locality, in orchards, but they have been comparatively harmless in the forests. June 14.

Herkimer county (George S. Graves, Newport)—The appletree bark louse [Mytilaspis pomorum] was exceedingly abundant on Pennsylvania maples in this vicinity. Feb. 11. The first appletree tent-caterpillars [Clisiocampa americana] were observed Ap. 26 in one place and in another May 4. No forest tent-caterpillars [Clisiocampa disstria] have been observed as yet. May 10. The cigar case-bearer [Coleophora fletcherella] is present on appletrees in large numbers and is doing considerable damage to the buds and maples. The nests of the appletree tent-caterpillar are not as plentiful as last year in this locality. Five appletrees here have been practically ruined by the appletree bark louse. The cold weather appears to have delayed the hatching of tent-caterpillar eggs. May 16. A few clusters of the forest tent-caterpillar have

been observed in this locality, but they are comparatively very rare. Currant worms [Pteronus ribesii] have appeared on currant bushes. The currant aphis [Myzus ribis] is not very abundant. May 21. Tent-caterpillars are comparatively scare thus far. A few forest tent-caterpillars were noticed in Poland 4 miles away. The appletree bark louse has also proved quite injurious to cultivated mountain ash and Crataegus in a yard. One orchard near a forest undergrowth is about equally infested with the appletree and forest tent-caterpillars. The cold seems to have kept the tent-caterpillars in check, but plant lice are very numerous and injurious. May 31. Colorado potato beetles [Doryphora 10-lineata] first appeared in considerable numbers May 26. Tent-caterpillars are relatively very scarce. The prolonged rainy weather seems to have kept some insects in check severely, though currant worms are plentiful and quite injurious. June 6. Cabbage butterflies [Pieris rapae] were noticed June 13, and on the 18th rose beetles were quite abundant. The onion thrips [Thrips tabaci] is working on our lettuce. The first grubs of the Colorado potato beetle were seen June 13. Grasshoppers seem to be more plentiful than last year and currant worms are unusually abundant. Not a cocoon of either tent-caterpillar has been observed. June 19. Squash bugs were first observed on the vines June 16. Grasshoppers are very plentiful, but so far no particular injury has been done by them. Potato beetles are unusually numerous. Rose beetles [Macrodactylus subspinosus] are attacking the appletrees and rapidly devouring the small apples. June 27. Rose beetles have now disappeared, and it does not seem as if they had caused much injury. Grasshoppers are reported very numerous in the valleys but not on the hills. The spinach flea beetle [Disonycha collaris] has been quite abundant in this vicinity. July 13 two specimens of the praying mantis [Mantis religiosa] were observed in this place, undoubtedly coming from the eggs sent me last spring, though I have been unable to find any young from their egg clusters. July 13. Caterpillars of the white marked tussock moth [Notolophus

leucostigma] were observed Aug. 2. Grasshoppers do not appear to have caused much damage locally, though they are very abundant. Tortoise beetle grubs [Coptocycla sp.] are quite plentiful and destructive to morning-glories. The yellow-necked appletree worms [Datana ministra] are quite numerous on appletrees. Aug. 12. The common squash bug [Anasa tristis] is unusually abundant. The harlequin milkweed caterpillars [Cycnia egle] are quite abundant in this locality. Aug. 20. Fall webworms [Hyphantria cunea] are very plentiful on a great variety of trees. Aug. 27. American sawflies [Cimbex americana] were found in considerable numbers on a willow tree. Sep. 18.

Jefferson county (George Staplin jr, Mannsville)—Appletree tent-caterpillars [Clisiocampa americana] were hatching Ap. 30. Horn or Texas flies [Haematobia serrata] were observed on cattle May 10. A cluster of forest tent-caterpillars [Clisiocampa disstria] were found on a maple tree May 22, and also a few with appletree tent-caterpillars on appletrees. Potato and May beetles are not plentiful. Appletree tent-caterpillars are not as abundant as they were at the same date last year. Green plant lice are abundant on appletrees. The cold, damp weather has undoubtedly kept many insects in check. May 22. There are very few green worms [Xylina species] on appletrees. Appletree tent-caterpillars are not doing very much damage, and the forest tent-caterpillars are very scarce. Plant lice are abundant on plumtrees, causing the leaves on the tips of the branches to curl very badly. The past week has been cold and rainy most of the time. June 13. Yellow-necked [Datana ministra] and red-humped [Schizura concinna] appletree caterpillars and fall webworms [Hyphantria cunea] have appeared in small numbers. Grasshoppers are very plentiful in southern Jefferson and northern Oswego counties. Plum curculios [Conotrachelus nenuphar] have done the most damage here. Other insects have not been plentiful enough to cause much injury except the plant lice, and they are very abundant. It has been warm and

dry for the last two or three weeks. Cabbage worms [Pieris rapae] are very abundant. Aug. 2. Fall webworms are very numerous on maples. Many dead grasshoppers are found in the fields. Sep. 3.

Livingston county (W. R. Houston, Geneseo)—Appletree tent-caterpillars [Clisiocampa americana] made their appearance Ap. 28 almost before the buds began to swell. They are just as numerous as last year. I understand that some farmers sprayed before the buds opened. The cold weather seems to keep them in check, and, though they wander over the trees, they do not seem to feed much. May 10. May 17 many nests of the appletree tent-caterpillar were seen in cherry and thorn trees beside the road, and there were also many unhatched eggs. May 24.

Montgomery county (S. H. French, Amsterdam)—The eggs of the European praying mantis [Mantis religiosa] were received in good condition and have been distributed as follows: one packet attached to a small rosebush in my back yard; one in the yard of a friend of mine who lives in the suburbs of the city; and the remainder in the cemetery, where there is plenty of small vegetation. Ap. 17. I have discovered no evidence of the presence in this section of the elm leaf beetle [Galerucella luteola] or of the forest tent-caterpillar [Clisiocampa disstria], and I find very few nests of the appletree tent-caterpillar [Clisiocampa americana]. The latter are not as numerous on cherry or apple trees as usual. May 13.

Niagara county (R. L. Darrison, Lockport)—A large proportion of the winter wheat is seriously damaged by the Hessian fly [Cecidomyia destructor], and where but a few weeks ago there was every promise of an abundant crop, many fields are ruined, and some farmers are now plowing their wheat under. The egg cases of the praying mantis [Mantis religiosa] were distributed among representative farmers, nurserymen and market gardeners, but as yet none have been reported as hatched. June 13. So far only one of the egg cases of the praying mantis has developed satisfactorily. This was placed in a

box with perforations for air and left out of doors except in stormy weather. The insects began to appear on July 2 and between then and the 5th about 100 hatched. All of the egg clusters placed outside or out of doors have apparently failed to develop any insects. July 12.

Oneida county (Jeanette C. Miller, Alder Creek)—Larch sawflies [Lygaeonematus erichsonii] are quite destructive to some trees in this vicinity. June 19. The argus beetle [Chelymorpha argus] has been very abundant on bindweed in this vicinity, and the sugar maple borer [Plagionotus speciosus] is doing considerable damage to our shade trees. July 25. Caterpillars of the eight-spotted forester [Alypia octomaculata] are abundant on Virginia creeper. July 31.

Onondaga county (Mrs A. M. Armstrong-Jackson, Belle Isle)—House flies [Musca domestica] are appearing, wasps [?Polistes pallipes] are becoming numerous, and the nests of the appletree tent-caterpillar [Clisiocampa americana] are beginning to appear. May 1. Canker worms [?Paleacrita vernata] made their first appearance here May 10, but they are not very abundant. Some appletrees have from seven to 10 webs of the appletree tent-caterpillar on them, and, where no means have been taken to check these pests, they are doing considerable damage. The bud moth larvae occur on apple, quince and plumtrees. Plant lice are present on currant bushes and also on the snowball tree. May 16. Forest tent-caterpillars [Clisiocampa disstria] were about half grown May 18, but they are not very destructive. Appletree tent-caterpillars are also doing some mischief in orchards. May 18 a white frost occurred and ice formed on the water in a pan. It apparently did not affect any caterpillars, as none were found dead, though many of them remained in their webs all day. The pistol and cigar case-bearers [Coleophora malivorella and C. fletcherella] are quite abundant on appletrees. Canker worms are not eating much and appear to grow very slowly. May 24. Potato beetles

[Doryphora 10-lineata] are very numerous and destructive. Grubs of the Pennsylvania soldier beetle [Chauliognathus pennsylvanicus] were observed feeding on little green lice. I also think that they feed on the bud moth caterpillars, as a number were found in the foliage recently occupied by them. The Hessian fly [Cecidomyia destructor] is quite abundant in many fields. Two weeks of almost continuous rain have somewhat retarded the development of the insects. June 7. Late sowing does not appear to be a preventive for the Hessian fly in this section. One field sown Sep. 10 was attacked by the fly and stooled freely, but none of the plants died, while in later sown fields much of the wheat was killed by the fall brood of the fly; specially was this true in fields where commercial fertilizers were used, and where the farmer was careless and allowed his fertilizer box to become empty part way across the field. A strip of Mediterranean wheat sown beside the other was very little affected by the fly, while the remainder (Gold coin) is badly infested. Canker worms are doing considerable damage in this vicinity. Two elms near by were defoliated by them. Appletree and forest tent-caterpillars are crawling about, but they are not abundant. Some cherrytrees are badly infested with plant lice, and their leaves are turning brown and drying up. Potato beetles are quite plentiful. June 14. The plum curculio [Conotrachelus nenuphar] has "stung" much fruit, and considerable of it is dropping, but for all that a full crop remains on the trees. The second brood of currant worms is doing considerable damage. Caterpillars are spinning up and canker worms are going into the ground. Some wheat fields in this vicinity are badly infested by the Hessian fly, while others do not appear to have suffered much. June 22.

Ontario county (J. Jay Barden, Stanley)—Appletree tent-caterpillars [Clisiocampa americana] appeared Ap. 25; forest tent-caterpillars [Clisiocampa disstria] Ap. 27; canker worms [?Paleacrita vernata] May 6; and the common asparagus beetle [Crioceris asparagi] May 7.

Appletree tent-caterpillars are not abundant where they were persistently fought last year. Forest tent-caterpillars and canker worms are very abundant in orchards in the vicinity of Rushville N. Y. Pistol case-bearers [Coleophora malivorella] and bud moths [Tmetocera ocellana] are very abundant in this section. The cold weather through April has retarded the appearance of many species. The currant stem girdler [?Janus integer] has been more abundant than ever before, and it is doing much damage. The work of the larvae is showing very plainly at present on account of the lack of foliage on the infested stems. May 10.

Orange county (J. M. Dolph, Port Jervis)—Willow and cabbage butterflies [Euvanessa antiopa and Pieris rapae] were observed May 1, and on the 6th June beetles were seen for the first time. Many maples in this vicinity show effects of the work of the sugar maple borer [Plagionotus speciosus]. May 9. Currant worms [Pteronus ribesii] were first observed May 14, and nests of the appletree tent-caterpillar [Clisiocampa americana] May 15. The appletree bark louse [Mytilaspis pomorum] is apparently less abundant than it was last year. Reports of the prevalence of appletree tent-caterpillars in orchards have come in from various places in this section, though they do not appear to be unusually abundant in this immediate neighborhood. Cutworms are very abundant in gardens. May 27. Fall webworms [Hyphantria cunea] have appeared in great numbers in and about Port Jervis. They seem to have developed suddenly, and they attack a great variety of trees. Aug. 30.

Orleans county (Virgil Bogue, Albion)—Caterpillars of the giant swallowtail [Heraclides cresphontes] were found on my orange tree. Plant lice are somewhat abundant on plum and cherry trees in this section. My crop of cherries was nearly all wormy, probably the work of the cherry fruit fly [Rhagoletis cingulata]. The wheat in this vicinity is in bad condition from attacks by the Hessian fly [Cecidomyia destructor]. Potato beetles [Doryphora 10-

lineata] are very thick and doing considerable damage. July 17.

Oswego county (C. D. Cook, Oswego Center)—Appletree tent-caterpillars [Clisiocampa americana], bud moths [Tmetocera ocellana] and cigar case-bearers [Coleophora fletcherella] appeared about the time the buds began to develop, the two former being abundant, the tent-caterpillars being exceedingly so. No forest tent-caterpillars [Clisiocampa disstria] have been observed thus far. Plant lice [Aphis mali] are abundant on appletrees, and many cigar case-bearers can be found. May 20. Currant worms [Pteronus ribesii] and cutworms are numerous and causing considerable injury. Plant lice are very abundant on plum, pear and apple trees. Tent-caterpillars have not caused much injury to the trees. The cold, wet weather has retarded the development of insect life. June 5. Hessian fly [Cecidomyia destructor] has caused considerable damage in this vicinity. June 19. The forest tent-caterpillar has been very destructive in Yates county, the woods about Penn Yan being brown and bare in places from their work. The appletree tent-caterpillar has also been quite injurious about Penn Yan. July 8.

Otsego county (L. I. Holdredge, Oneonta)—Willow and cabbage butterflies [Euvanessa antiopa and Pieris rapae] have made an early appearance this season, and the currant plant louse [Myzus ribis] is present in great numbers. May 6.

Queens county (C. L. Allen, Floral Park)—Cabbage butterflies [Pieris rapae] appeared in large numbers about May 10. The rains have destroyed nearly all of them, however. Potato beetles [Doryphora 10-lineata] are less numerous than usual. June 21. The destructive pea aphis [Nectarophora pisi] appeared about June 18, and thus far it has done but little damage. At the present time there are few or none to be seen, the severe rains having apparently destroyed them. July 9. Fall webworms [Hyphantria cunea] appeared in im-

mense numbers about the middle of August, and their webs were very conspicuous on a great many trees. They are doing immense damage in this vicinity. Aug. 29.

Rensselaer county (W. C. Hitchcock, Pittstown)—Appletree tent-caterpillars [Clisiocampa americana] are present in immense numbers. May 20. The cold, wet weather appears to have kept both the appletree and forest tent-caterpillars [Clisiocampa disstria] in check, as they seem to have been very scarce. The elm leaf beetle [Galerucella luteola] is not proving very destructive this season. July 2. Round-headed appletree borers [Saperda candida] are quite injurious in this section. The trees receive little attention, and are therefore soon ruined by the borers. Grasshoppers are unusually scarce. July 15.

Rockland county (S. B. Huested, Blauvelt)—Appletree tent-caterpillars [Clisiocampa americana] first appeared May 4. The season has been cold and backward. May 8. We have not seen the June beetle as commonly as last year. Last month potato beetles [Doryphora 10-lineata] were very troublesome. Aug. 5.

St Lawrence county (Mary B. Sherman, Ogdensburg)—Shad or May flies appeared as usual June 5 and were very abundant for three days. Forest tent-caterpillars [Clisiocampa disstria] are scarce, only four or five having been seen during the summer. Currant worms [Pteronus ribesii] appeared about a week ago. There are many complaints of injury by wireworms. June 22. Caterpillars of the white marked tussock moth [Notolophus leucostigma] are abundant. July 8. Complaints of injury by currant worms are less frequent than usual. Plant lice are unusually abundant and destructive. July 12. Cabbage butterflies [Pieris rapae] are now quite abundant. A large number of cut-leafed birches have been seriously damaged, without apparent cause. [This is possibly the work of the bronze birch borer, Agrilus anxius.] All plant lice are unusually abundant. Many complaints are made regarding the abundance of fleas

on cats and dogs. Potato beetles [Doryphora 10-lineata] and cabbage worms are very abundant. Aug. 2. The birch leaf Bucculatrix [Bucculatrix canadensisella] is exceedingly abundant in this vicinity, having skeletonized the majority of the leaves on almost all the birches in this region. Sep. 12.

Saratoga county (Miss Rhoda Thompson, Ballston Spa)—There are fewer appletree tent-caterpillars [Clisiocampa americana] and more plant lice and cutworms than there have been for the last two years. Currant worms [Pteronus ribesii] have also been very abundant. June 7. Rose beetles [Macrodactylus subspinosus] and wireworms are about as abundant as usual. Squash bugs [Anasa tristis] are present in enormous numbers and are causing considerable injury. July 12. There is a plague of grasshoppers in this vicinity, and they are doing a great deal of mischief. It was found they had cut off from two thirds to three fourths of the grain in a field of oats. Corn has also been much injured. Some farmers are cutting their grain before maturity in order to save it from injury.

Schenectady county (Paul Roach, Quaker Street)—Forest tent-caterpillars [Clisiocampa disstria] were first observed on the south side of the woods. May 5. Appletree tent-caterpillars [Clisiocampa americana] and forest tent-caterpillars will probably be fewer than last year. The cold, wet weather appears to have retarded the hatching of eggs and development of insect life. Bud moth larvae [Tmetocera ocellana] are present in small numbers. May 8. There are only a few appletree tent-caterpillars on the wild cherrytrees. The season has been cold and excessively wet, and not many of the caterpillar eggs appear to have hatched. May 31.

Schoharie county (John F. Johnson, Breakabeen)—Appletree tent-caterpillars [Clisiocampa americana] were first observed May 1, and forest tent-caterpillars [Clisiocampa disstria] May 7. The former are abundant, and the latter not more than half as numerous as last year. The cold, rainy

weather seems to have kept insect pests in check. May 13. Forest tent-caterpillars have not done much damage. They are about one third as abundant as last year. Plant lice are quite numerous on apple, plum and cherry trees. Currant worms [Pteronus ribesii] are quite abundant in this vicinity. June 6. Potato beetles [Doryphora 10-lineata] have appeared, and plant lice are quite abundant on cherrytrees, causing the leaves to shrivel and die. Forest tent-caterpillars are spinning their cocoons and have not caused much damage. Grasshoppers are present in large numbers. The moths of the forest tent-caterpillar appeared July 1 and have commenced to deposit eggs. Potato beetles are very abundant. July 11. Grasshoppers are very numerous and are injuring corn and buckwheat. Aug. 12.

Schuyler county (Harriet M. Smith, North Hector)—Appletree tent-caterpillars [Clisiocampa americana] were first seen May 1, canker worms [?Paleacrita vernata] May 6. The latter have been very destructive to buds and small leaves on plumtrees. The tent-caterpillars are very abundant, but have caused but little damage as yet. May 17. Both the common and the 12 spotted asparagus beetles [Crioceris asparagi and C. 12-punctata] are abundant. Canker worms are defoliating many maple trees. Owing to the destruction of the nests of the appletree tent-caterpillar in orchards, this pest has caused but little injury in this vicinity. The late storm has apparently killed many insects. June 7. White marked tussock moth caterpillars [Notolophus leucostigma] have been quite injurious to horse chestnut trees. Oats are reported as seriously damaged by a plant louse in Seneca county. July 12. I am unable to learn of any wheat being seriously injured by the Hessian fly [Cecidomyia destructor] in this vicinity, as most of it was sown late. June 14. Potato beetles [Doryphora 10-lineata] appeared for the first time this season about June 15, and they are now present in great abundance. June 21. The Hessian fly has injured wheat at North Reading. July 19.

Seneca county (J. F. Hunt, Kendaia)—Appletree tent-caterpillar [Clisiocampa americana] eggs hatched Ap. 26, and those of the forest tent-caterpillar [Clisiocampa disstria] May 3. Canker worms [? Paleacrita vernata] commenced work on appletrees about May 1. May 7. Cherry aphids [Myzus cerasi] have just begun to appear. Both appletree and forest tent-caterpillars are less abundant than last year. There are not so many nests of the former species to be seen. The steely blue grapevine beetle [Haltica chalybea] has not been seen this spring in localities where it was abundant last year. May 17. Currant worms [Pteronus ribesii] appeared May 20, and work of the plum curculio [Conotrachelus nenuphar] is now evident, but this pest is not so injurious as in former years. The forest tent-caterpillar in particular is not so abundant as it has been in recent years. Bud moths [Tmetocera ocellana] are more numerous than for years. Currant worms and raspberry sawflies [Monophadnoides rubi] are both scarce. The fruit tree bark beetle [Scolytus rugulosus] is working quite abundantly in plum and peach-trees, but not so badly, however, in the latter. The orchard which the canker worms defoliated last year and in which they appeared this year is now all right, the pests having been controlled by two sprayings. May 29. The work of the Hessian fly [Cecidomyia destructor] is now in evidence, it having destroyed about one third of some species of wheat, and there are but few curculio marks on apricots and plums. Tent-caterpillars are showing up a little more abundantly than was reported last week. There are no potato beetles [Doryphora 10-lineata] to speak of yet. The last week of rain has apparently had no bad effect on the caterpillars. June 7. Eggs of the potato beetle are beginning to hatch, and the parent insects are very plentiful. Tent-caterpillars are now leaving the trees and spinning cocoons. The Hessian fly is very destructive in some pieces of wheat, while in others not much is seen of it. Zebra caterpillars [Mam-

estra picta] were found in small numbers on a red raspberry bush. June 21. Squash bugs [Anasa tristis] are very numerous and in some gardens have destroyed all the vines. The small black flea beetle [Epitrix cucumeris] is very abundant in some bean fields. The work of what is evidently a Thrips is very plain in many timothy fields. The Hessian fly is not causing so much damage in this vicinity as was at first feared. July 10. The cherry fruit fly [Rhagoletis cingulata] has caused some injury in this vicinity, and I have been able to catch the flies on the fruit. I have gone over my cherry orchard twice and a part of it three times and have gathered from it the affected fruit, which was then put into vessels containing water, and the maggots drowned. I picked 25 pounds of infested cherries from four trees, and bushels of wormy ones, in my orchard. Cucumber flea beetles are quite injurious to potato vines. The Hessian fly has completely destroyed all the barley and spring wheat in this section. Winter wheat in the center of the county is good, while at each end it is badly damaged by the fly. July 24.

Tompkins county (C. E. Chapman, Peruville)—Appletree tent-caterpillars [Clisiocampa americana] appeared May 1, and on the 9th they were very abundant. May 14. Hessian fly larvae [Cecidomyia destructor] are in nearly every wheat stalk, from one to four in each. Many fields are nearly ruined, and the yield will not be more than one half the usual crop. The wheat also appears to be damaged by an insect which eats the straw nearly in two about an inch from the surface of the ground. It is probably the work of the sawfly [?Cephus pygmaeus]. Forest and appletree tent-caterpillars are on all the trees in this section but not in sufficient numbers to cause much damage. June 25. Chinch bugs [Blissus leucopterus] occur here and there in small spots on different farms. One piece of millet was badly injured. They have also attacked grass among blackberry bushes. Grasshoppers are very thick, but wet weather appears to keep them in check. Squash and other vines have been nearly de-

stroyed by the common stink or squash bug [Anasa tristis]. The apples are much infested with codling moth larvae [Carpocapsa pomonella]. Potato beetles are very abundant. Aug. 20.

Ulster county (George S. Clark, Milton)—Currant worms [Pteronus ribesii] were first observed May 7, and only a few are to be found at the present date. Appletree tent-caterpillars [Clisiocampa americana] were first seen about May 1, and in sections where they were kept under control last year, there are only a few, but in other places they are doing considerable damage. May 16. Cherry aphis [Myzus cerasi] is rather abundant on cherrytrees. May beetles are present in some numbers and are cutting the leaves of trees badly. May 31. Plant lice appear to be increasing slowly. Appletree tent-caterpillars are now wandering considerably. June 7. Cucumber flea beetles [Epitrix cucumeris] are at work on tomato and potato vines, injuring them considerably. Some trees in this section have been entirely defoliated by tent-caterpillars, but this is exceptional. June 14. Cherry plant lice are quite injurious to young trees. June 21. There are very few currant worms in the second brood. The potato beetles [Doryphora 10-lineata] are easily controlled. June 28. The lightning leaf-hopper [Ormenis pruinosa] is quite abundant in a pear and currant plantation, being so numerous as to partly cover many of the twigs with their cottony secretion. It is not an injurious species as a rule. July 11.

Warren county (C. L. Williams, Glens Falls)—Forest tent-caterpillars [Clisiocampa disstria] are generally distributed in this section, but they have not been numerous enough to cause much of any damage. The caterpillars of the white marked tussock moth [Notolophus leucostigma] are present in small numbers. July 5.

Wayne county (C. H. Stuart, Newark)—I am sending you a worm found in quince seedlings which proved to be the larva of the leopard moth [Zeuzera pyrina]. June 30. The Hessian fly [Cecidomyia destructor] is even worse

here this year than last, when it attacked nearly three fourths of the crop. Our season has been extremely wet, and I think that both of the tent-caterpillars and aphids have been later than usual, but now they are very abundant. June 5. Canker worms [? Paleacrita vernata] are even worse than last year, and very little effort is being made to check them. They have attacked forest trees badly in some sections, seeming to favor the elms and spreading from them to neighboring orchards. The appletree and forest tent-caterpillars [Clisiocampa americana and C. disstria] are very abundant on apple and cherry trees, but during a long drive yesterday, I saw nests only in apple and cherry trees. This is a great contrast to last year, when they worked on nearly everything. They are now crawling along the fences, sidewalks and roads, looking for places in which to spin up. Our fields (we have some 60 acres scattered around in different places) look uniformly bad from attack by the Hessian fly. They were sowed beginning Sep. 20 and ending a week later. Our wheat is as near a complete failure as it is possible to be and yield anything. We may get 5 or 6 bushels to the acre, but we shall probably plow the greater part of it. Both asparagus beetles are present here, but the 12 spotted one [Crioceris 12-punctata] is rare. The common form [Crioceris asparagi] is so bad that it is almost impossible to find any asparagus on the market except that which is covered with its eggs. June 11. I am mailing a number of apricot twigs infested with what is apparently a peach twig moth. [Cenopis diluticostana Walsm., kindly determined by Prof. C. H. Fernald, subsequently was bred from these twigs.] The pale striped flea beetle [Systena taeniata] observed by us working on seedling appletrees last year, is now attacking sugar beets. June 24. The small beetles [Notoxus anchora] sent herewith are very numerous around the roots of wheat. In our seed bed we have several varieties of wheat, all of which were badly injured by the Hessian fly except a check row of "Dawson's golden chaff," not a single straw of which is down. This check row was sown

by hand, the rest by machine, and was put in about 1 inch deeper than the rest. All the varieties were sown at about the same time. June 28.

Westchester county (Mrs. Edwin H. Mairs, Irvington-on-Hudson)—Appletree tent-caterpillars [Clisiocampa americana] were observed in immense numbers. May 7. We have had few warm days and a great deal of cold wet weather, which has kept insect life pretty well in check. May 14. The grapevine plume moth caterpillars [Oxyptilus periscelidactylus] are doing some injury to grapevines. The beech aphis [Phyllaphis fagi] is present on purple beeches. Appletree tent-caterpillars are still very abundant. May 29. They are now leaving the trees and crawling in every direction in search of places in which to spin up. In one orchard I saw enough of them to stock the earth. June 6. Green June beetles [Allorhina nitida] were first observed July 7. They eat out the buds of the common flowers and are destroying the plants. This is the insect which has been reported in the newspapers as the wonderful "flying, boring bug." Spotted grapevine beetles [Pelidnota punctata] have appeared in great numbers. The common June beetles are somewhat troublesome. White marked tussock moth caterpillars [Notolophus leucostigma] are present in small numbers. July 20. Fall webworms [Hyphantria cunea] are very abundant in this section, and their nests can be seen on a great variety of trees and shrubs. Sep. 6.

Wyoming county (W. H. Roper, Wyoming)—Appletree tent-caterpillars [Clisiocampa disstria] appeared May 2. They are plentiful, but are not doing much damage as yet, since the weather is cool and damp. May 13. They have not been working for the last three days, because the weather has been cold, but not cold enough to kill them. May 17. The tent-caterpillars are doing a great deal of damage in this locality where the trees have not been sprayed. The canker worm [? Paleacrita vernata] has also made his appearance and is causing a great deal of injury. Had it not been for the

cold, wet weather, the caterpillars would have caused a great deal more damage than they have. May 29. Tent-caterpillars and canker worms are devouring the foliage very rapidly in some orchards. The latter are not doing as much injury in the woods this year as last. June 7. I find no canker worms in my orchard, but there are a great many in this vicinity, and the elm-trees are full of them. Some trees have been entirely defoliated. The Hessian fly [Cecidomyia destructor] has caused a great deal of injury to wheat in this section, and many crops will not be harvested because there is nothing worth cutting. The white wheat has been severely injured, while the red wheat has apparently escaped with little or no harm. June 19. I have four acres of white wheat which was sown Sep. 19. It has not been injured by the fly. It is known as the "Genesee giant." The straw is very coarse and stands up in fine shape. My no. 6, sowed the next day, is about one half gone. The wheat on the hills has been injured much more than that in the valley. July 3.

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year 1901. 62 are given with title,[1] place and time of publication and a summary of the contents of each. Volume and page numbers are separated by a colon, the first superior figure tells the column, and the second the exact place in the column in ninths; e. g. 65: 862[18] means vol. 65, p. 862, column 1, beginning in the eighth ninth, i. e. about eight ninths of the way down.

Grain moth (Country gentleman, 25 Oct. 1900, 65: 862[18])

The attack on wheat at Highlands N. J. is identified as that of Sitotroga cerealella Oliv.

Wooly aphis (Country gentleman, 25 Oct. 1900, 65: 862[44])

Identifies and gives remedies for Schizoneura lanigera Hausm. attack on appletrees at Troy N. Y.

[1] Titles are given as published; and in some instances they have been changed or supplied by the editors of the various papers.

Whale oil soap experiments (Country gentleman, 1 Nov. 1900, 65: 884[41])

Gives results obtained with Good's whale oil soap.

Celery Plusia (Country gentleman, 1 Nov. 1900, 65: 884–85[46])

Plusia simplex Guen. is identified from Colora Md., its life history is given, and remedies indicated. Ormenis [Poeciloptera] septentrionalis Spin. is mentioned.

Some effects of early spring applications of insecticides on fruit trees (U. S. dep't agric. div. ent. Bul. 26, n. s. 1900. [rec'd Nov. 8] p. 22–25)

Gives effects of kerosene, crude petroleum and whale oil soaps in various dilutions and mixtures.

Hessian fly (Country gentleman, 22 Nov. 1900, 65: 942[25])

Gives rule for ascertaining date of disappearance of [Cecidomyia destructor Say] and recommends preventive measures.

Remedies for San José scale (Country gentleman, 29 Nov. 1900, 65: 965[21])

Summarizes results obtained with kerosene, crude petroleum, whale oil soaps and hydrocyanic acid gas. A 20% mechanical emulsion of crude petroleum proved very satisfactory. Whale oil soap was not so efficient. Hydrocyanic acid gas was the most satisfactory, but its application is limited on account of the costly tents.

Scale on Japan plum (American gardening, 8 Dec. 1900, 21: 811[21])

San José scale, Aspidiotus perniciosus Comst., from Rye N. Y., is identified, and early spring treatment with whale oil soap or crude petroleum advised.

Work of the state entomologist (Albany evening journal, 18 Dec. 1900, p. 4)

Replying to a suggestion, the work of the office is briefly outlined.

Wheat damaged by moth (Country gentleman, 10 Jan. 1901, 66: 24[32])

Gives remedies for Angoumois or grain moth, Sitotroga cerealla Oliv., which is reported abundant in New Jersey.

Serious injury by bark-borers (Riverhead [N. Y.] news, 26 Jan. 1901, p. 1–30 cm)

A brief account of injuries to hard pines at Manor L. I. by Tomicus calligraphus Germ., T. cacographus Lec. and Dendroctonus terebrans Oliv. Several preventive measures are advised.

Wireworms (Country gentleman, 28 Feb. 1901, 66: 168)

The larva of Melanotus communis Gyll. from Orange county, N. Y. is identified, and several preventive and repressive measures advised.

[Insect lessons of the year] (Country gentleman, 28 Feb. 1901, 66: 170[24], 7 Mar. p. 192)

Extracts from report of committee on insects of Eastern N. Y. horticultural society, in which the following are noticed: pale striped flea beetle, Systena taeniata Say, gipsy moth, Porthetria dispar Linn., appletree aphis, Aphis mali Fabr., cherrytree aphis, Myzus cerasi Fabr., destructive pea louse, Nectaro|phora pisi Kalt., white flower cricket, Oecanthus niveus DeG., the minute black lady-beetle, Pentilia misella Lec., fruit tree bark beetle, Scolytus rugulosus Ratz., palmer worm, Ypsolophus pometellus Harr., forest tent-caterpillar, Clisiocampa disstria Hübn. and the leopard moth, Zeuzera pyrina Fabr. The second part is a discussion of results obtained in experiments against San José scale with kerosene, whale oil soap and crude petroleum in various combinations.

Scurfy bark louse (Country gentleman, 28 Mar. 1901, 66: 256–57[46])

Chionaspis furfura Fitch on pear and apple trees is briefly characterized, and remedies given.

Grapevine Aspidiotus (Country gentleman, 4 Ap. 1901, 66: 278–79[47])

Aspidiotus uvae Comst. from Nashville Tenn. is identified, compared briefly with the San José scale, and remedial measures are indicated.

Injurious insects and how to control them. (N. Y. state agric. soc. Rep't 1899. 1900. pt 2. Bureau of farmers institutes. Rep't [issued 15 Ap. 1901] p. 267–93. Also Dep't agric. 7th rep't. 1900. v. 3, pt 2, p. 59–85)

General paper treating of a number of insects, the appletree tent-caterpillar, Clisiocampa americana Fabr., forest tent-caterpillar, Clisiocampa disstria Hübn., codling moth, Carpocapsa pomomella Linn., sugar maple borer, Plagionotus speciosus Say, elm borer, Saperda tridentata Oliv., elm leaf beetle, Galerucella luteola Müll., appletree and scurfy bark lice, Mytilaspis pomorum Bouché and Chionaspis furfura Fitch, and the San José scale, Aspidiotus perniciosus Comst. being specially mentioned.

A large number of the more important insect pests are briefly characterized, and remedies for them are given in the reprinted catalogue of the collection exhibited at certain institutes.

Household insects (N. Y. state agric. soc. Rep't, 1899. 1900. pt 2 Bureau of farmers institutes. Rep't [issued 15 Ap. 1901] p. 294–303. Also Dep't agric. 7th rep't. 1900. v. 3, pt 2, p. 86–95)

A general paper treating of the following: mosquitos, Culex, house fly, Musca domestica Linn., fleas, Ceratopsyllus serraticeps Gerv., carpet beetles, Anthrenus scrophulariae Linn. and Attagenus piceus Oliv. and clothes moths, Tinea pellionella Linn. and others, house ants, Monomorium pharaonis Linn. and others, cockroaches, Phyllodromia germanica Fabr. and Periplaneta orientalis Linn., bedbug, Acanthia lectularia Linn., larder beetle, Dermestes lardarius Linn., cheese or ham skipper, Piophila casei Linn., fruit flies, Drosophila ampelophila Loew, bristle tail or fish moth, Thermobia furnorum Rov.

16th report of the state entomologist on injurious and other insects of the state of New York (N. Y. state mus. Bul. 36. 1901. [issued 25 Ap.] p. 949–1063)

Contents

1 General account of each, giving life history and habits.
2 Brief records of some of the more interesting facts brought to notice in 1900.

Tent-caterpillars (Country gentleman, 9 May 1901, 66: 386[34])

Remedies are given for both species.

Enemies of trees (Troy daily times, 10 May 1901, 37cm)

Brief general accounts of the elm leaf beetle, *Galerucella luteola* Müll., forest tent-caterpillar, *Clisiocampa disstria* Hübn., and the elm bark louse, *Gossyparia ulmi* Geoff.

Entomologic service of New York (Country gentleman, 16 May 1901, 66: 403[22])

Summary of reports from voluntary observers.

Trap-lanterns—Warning (Country gentleman, 16 May 1901, 66: 406[17]; New York farmer, 16 May 1901, p. 3)

Statement to the effect that trap lanterns are of value in only a few very special cases.

Spraying and poultry (Country gentleman, 23 May 1901, 66: 423[23])

Grass under properly sprayed trees will not be injurious to poultry.

Scale on raspberry (Country gentleman, 23 May 1901, 66: 423[33])

Aulacaspis rosae Sandb. from Concordville Pa. is identified, and the proper treatment indicated.

Hessian fly—borers (Country gentleman, 30 May 1901, 66: 442[37])

Preventive methods are given for *Cecidomyia destructor* Say, the fruit tree bark-borer, *Scolytus rugulosus* Ratz., and the locust borer, *Cyllene robiniae* Forst.

Entomologic service of New York (Country gentleman, 30 May 1901, 66: 443[13])

Summary of reports from voluntary observers.

Recent problems in the control of insects depredating on fruit trees (Mass. fruit growers ass'n. 7th rep't. 1901 [rec'd 6 June] p. 27–45)

The following topics are treated: Care of literature, Dissemination of insects, Results obtained in 1900 with insecticides, the latter principally a discussion of kerosene, whale oil soaps and crude petroleum.

Voluntary entomologic service of New York state (Country gentleman, 6 June 1901, 66: 462–63[47])

Summary of reports from voluntary observers.

Voluntary entomologic service of New York state (Country gentleman, 13 June 1901, 66: 482[34])

Summary of reports from voluntary observers.

Hessian fly (Country gentleman, 13 June 1901, 66: 486[42]; New York farmer, 13 June 1901, p. 8; —— 27 June, p. 7; American agriculturist, 22 June 1901, p. 816, col. 1)

Brief statement of injuries by Hessian fly, Cecidomyia destructor Say, and a request for data concerning infested fields.

Hickory gall—San José scale (Country gentleman, 20 June 1901, 66: 502[35])

The life history and characteristics of Phylloxera caryaecaulis Fitch are briefly given, and Aspidiotus perniciosus Comst. is identified. Both are from Bedford Station N. Y.

Voluntary entomologic service of New York state (Country gentleman, 20 June 1901, 66: 503[14])

Summary of reports from voluntary observers.

Voluntary entomologic service of New York state (Country gentleman, 27 June 1901, 66: 523[23])

Summary of reports from voluntary observers.

Lunate long sting (Country gentleman, 4 July 1901, 66: 542–43[46])

A brief notice of Thalessa lunator Fabr. from Loudonville N. Y., with mention of its host, the pigeon tremex, Tremex columba Linn.

Voluntary entomologic service of New York (Country gentleman, 4 July 1901, 66: 543[23])

Summary of reports from voluntary observers.

Fruit tree bark beetle (Country gentleman, 4 July 1901, 66: 554[11])

Brief general account of Scolytus rugulosus Ratz. in New York state.

Squash bug (Country gentleman, 11 July 1901, 66: 562[32])

Anasa tristis DeG. is figured and briefly noticed.

Voluntary entomologic service of New York state (Country gentleman, 11 July 1901, 66: 563[17])

Summary of reports from voluntary observers.

Leaf-cutter bee (Country gentleman, 18 July 1901, 66: 582[33])

Cells of Megachile species from Chase Lake N. Y. are identified and the habits of insect given.

Voluntary entomologic service of New York (Country gentleman, 18 July 1901, 66: 583[13])

Summary of reports from voluntary observers.

Voluntary entomologic service of New York (Country gentleman, 25 July 1901, 66: 603[13])

Summary of reports from voluntary observers.

Plum curculio (Country gentleman, 25 July 1901, 66: 604[26])

Work of beetles of Conotrachelus nenuphar Hbst. on plum leaves is identified, and remedy given. Codling moth larvae in quince and a blight noticed briefly. All were from Setauket L. I.

Voluntary entomologic service of New York (Country gentleman, 1 Aug. 1901, 66: 623[13])

Summary of reports from voluntary observers.

Larch lappet (Country gentleman, 8 Aug. 1901, 66: 642[23])

The larva of Tolype laricis Fitch from Coldwater N. Y. is identified, and its peculiarities sketched.

Voluntary entomologic service of New York state (Country gentleman, 8 Aug. 1901, 66: 442–43[48])

Summary of reports from voluntary observers.

A great insect book (Country gentleman, 8 Aug. 1901, 66: 646–47[45])

A review, with some editorial additions, of the *Insect book* by Dr L. O. Howard.

Rabbit botfly (Poultry monthly [Albany N. Y.] Sep. 1901, p. 497–98)

Identifies maggot from Belgian hare in New York as probably Cuterebra cuniculi Clark and gives its life history briefly and remedies.

Borers in shade trees (American gardening, 10 Aug. 1901, 22: 558)

Poplar borer at New York is possibly Saperda calcarata Say. Injection of carbon bisulfid is recommended, or the use of potassium cyanid.

Blister beetles (Country gentleman, 15 Aug. 1901, 66: 662[17])

Margined blister beetle, Epicauta cinerea Forst., from Lahaska Pa. is identified, and remedies given.

Cicada-killer (Country gentleman, 22 Aug. 1901, 66: 682[34])

Sphecius speciosus Drury from Stillwater N. J. is identified, and its occurrence at Karner N. Y. recorded.

Sugar maples injured (Country gentleman, 19 Sep. 1901, 66: 762[47])

The depredator at Dutchess county, N. Y., is identified as probably Cacoecia argyrospila Walk.

Ichneumon fly (Country gentleman, 26 Sep. 1901, 66: 782[14])

Paniscus geminatus Say from Croton on Hudson N. Y. is described and identified.

Orange dog (Country gentleman, 26 Sep. 1901, 66: 782[15])

The larva of Heraclides cresphontes Cram. from Albany N. Y. is described, and its unusual abundance in New York noted.

Angoumois moth (Country gentleman, 26 Sep. 1901, 66: 782[24])

Sitotroga cerealella Oliv. from Smithtown L. I. is identified, and remedial measures given.

Birch leaf Bucculatrix (Country gentleman, 26 Sep. 1901, 66: 787[29])

A brief account of the prevalence and destructiveness of Bucculatrix canadensisella Chamb. in New York state.

Golden oak scale and leaf feeder (Country gentleman, 26 Sep. 1901, 66: 789[23])

This scale, Asterolecanium variolosum Ratz., is described, remedies given and the leaf feeder identified as possibly Symmerista albifrons Abb. & Sm.

Ants on fig trees (Country gentleman, 26 Sep. 1901, 66: 789[28])

Several means of keeping these insects out of trees are discussed. The ants are said to devour the fruit.

Celery worms (Country gentleman, 26 Sep. 1901, 66: 789[35])

The caterpillar, Papilio polyxenes Fabr., from Islip L. I. is described, and the use of slug shot on celery discountenanced. Hand picking is advised.

Saddle back caterpillar (Country gentleman, 26 Sep. 1901, 66: 789[38])

The larva of Sibine stimulea Clem., from Greenwich Ct., is described, and its food plants given.

Hessian fly in New York state (Country gentleman, 3 Oct. 1901, 66: 799[43]–800[11])

Summary account of injuries by Cecidomyia destructor Say, with remedial measures.

Appletree borer (Country gentleman, 3 Oct. 1901, 66: 803[28])

Remedial and preventive measures for Saperda candida Fabr. are given.

Borers and plant lice (Country gentleman, 10 Oct. 1901, 66: 829[11])

A general account of injuries to firs in the Adirondacks by Tomicus balsameus Lec. with mention of other species. General directions are given for the use of insecticides.

CONTRIBUTIONS TO COLLECTION 16 OCT. 1900–15 OCT. 1901

Hymenoptera

Apis mellifica Linn., honey bee, queen and workers, 5 Oct.; from **Harold Horner**, Mount Holly N. J.

Xylocopa virginica Drury, carpenter bee, pupae in hard pine board, 30 July; from **James F. Feeney**, Albany N. Y.

Megachile sp.; cells, 23 July; from **Harriet M. Smith**, North Hector N. Y.

Vespa maculata Linn., white-faced hornet, nest, 30 Ap.; from Mrs **C. L. Hoffman**, Castleton N. Y. Large nest of same, 19 Ap.; from Samuel Brutkus, New Baltimore N. Y.

Sphecius speciosus Drury, cicada-killer, adult, 12 Aug.; from **S. P.**, Stillwater N. J.

Sphex ichneumonea Linn., 8 Sep.; from Miss **Eliza S. Blunt**, New Russia N. Y.

?Sphaerophthalma occidentalis Linn., velvet ant, 7 Sep.; from Dr **M. W. Van Denburg**, Mount Vernon N. Y.

Dibrachys boucheanus Ratz., adults issuing from braconid cocoons on a sphingid larva, 13 Aug.; from **B. F. Koons**, Storrs Ct.

Thalessa lunator Fabr., lunate long sting, adult, 25 June; from **C. S. Bradt**, Albany N. Y. Same, 25 June; from **L. Tucker & Son**, Albany N. Y. Same, 28 July; from **C. W. Walker**, McGregor Ia. Same, 13 Sep.; from **C. J. Moore**, Albany N. Y.

Thalessa atrata Fabr., black long sting, adult, 29 May; from **O. Q. Flint**, Athens N. Y. Same, 25 June; from **C. S. Bradt**, Albany N. Y. Same, 2 July; from **Fred Calhoun**, Albany N. Y.

Paniscus geminatus Say, adult, 18 Sep.; from **J. H. H.**, Croton on Hudson N. Y.

Tremex columba Linn., pigeon tremex, adult on decayed and dying elm, 24 Aug.; from **Jeanette C. Miller**, Aldercreek N. Y.

? Cephus pygmaeus Linn., wheat sawfly, larvae in wheat stalks, 9 July; from **C. H. Stuart**, Newark N. Y.

Lygaeonematus erichsonii Hartig., larch sawfly, larvae on larch, 19 June; **Jeanette C. Miller**, Aldercreek N. Y.

Cimbex americana Leach, American sawfly, adult, 5 June; from **Dr J. Benton Tipton**, Albany N. Y. Larvae of same on willow, 16 Sep.; from **G. S. Graves**, Newport N. Y. They must have been very abundant, as numerous examples were sent.

Coleoptera

Scolytus rugulosus Ratz., fruit tree bark beetle, larvae and pupae on peach, 16 Mar.; from **J. A. Hepworth**, Marlboro N. Y. Same on plum, 25 June; **A. M. W.**, Troy N. Y.

Madarus undulatus Say., adult from fruit of thorn bush, 10 Oct.; from **C. H. Peck**, Lansingburg N. Y.

Balaninus rectus Say, chestnut weevil, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Conotrachelus nenuphar Herbst., plum curculio, adult work on plum leaves, 12 July; from **S. B. Strong**, Setauket N. Y.

Lixus concavus Say, rhubarb curculio, adult, 5 June; from **J. H. Ball**, North Nassau N. Y.

Hylobius confusus Kirby, adult, 10 June; from **Charles Heindel**, Albany N. Y.

Hylobius pales Herbst., pales weevil, adult, 5 Nov.; from **G. W. Cravens**, Schenectady N. Y. Same, 6 May; from **C. H. Peck**, Menands N. Y.

Epicauta pennsylvanica DeG., black blister beetle, adults seriously injuring sugar beets and destroying some patches, 15 Aug.; from **J. W. Calkins**, Cobleskill N. Y. Same on potato vines and china asters, 30 Aug.; from **Ira L. Peck**, Charleston Four Corners N. Y.

Epicauta cinerea Forst., margined blister beetle, adults on anemones, 5 Aug.; from **R. M.**, Lahaska Pa.

Epicauta vittata Fabr., striped blister beetle, very numerous on beets, potatoes, beans, tomatoes, 16 Aug.; from Senator **Ambler**, Valatie N. Y. They are said to have eaten up all the beets and tomatoes and now to be devouring the potatoes.

Notoxus anchora Hentz., adults numerous around the roots of wheat, 27 June; from **C. H. Stuart**, Newark N. Y.

Pytho americanus Kirby, adults, under decaying bark, 18 Nov.; from **J. A. Otterson**, Berlin Mass.

Diaperis hydni Fabr. from Polyporus spumeus, 9 Oct.; from Mrs **Dallus**, Buena Vista Spring Pa.

Tenebrio molitor Linn., meal worm, pupae, found in a trunk, 28 May; from **George H. Hunter**, Albany N. Y. Same 23 Aug.; from **Jeanette C. Miller**, Aldercreek N. Y.

Upis ceramboides Linn., 27 May; from **Eliza S. B. Blunt**, New Russia N. Y.

Chelymorpha argus Licht., argus beetle, larvae, pupae, adults on bindweed, 23 July; from **Jeanette C. Miller**, Aldercreek N. Y.

Systena hudsonias Forst., red-headed flea beetle, adults on grape, 7 Aug.; from **J. J. Barden**, Fredonia N. Y.

Crepidodera cucumeris Harr., cucumber flea beetle, adults on bean and potato vines, 24 July; from **J. F. Hunt**, Kendaia N. Y.

Disonycha collaris Fabr., spinach flea beetle, larva on spinach, 3 July; from **G. S. Graves**, Newport N. Y.

Galerucella luteola Mill., elm leaf beetle on elm, 6 Aug.; from **Jane Bassett**, Bridgewater Mass.

Doryphora 10-lineata Say, potato beetle, work of adult on stalks of potatoes, 2 July; from **J. F. Rose**, South Byron N. Y.

Colaspis brunnea Fabr., brown Colaspis, adult on grapevine, 7 Aug.; from **J. J. Barden**, Fredonia N. Y.

Typophorus canellus Fabr., strawberry root worm, on elm, 6 June; from **Cyrus R. Crosby**, Cranberry Creek N. Y.

Chrysochus auratus Fabr., gold gilt beetle, adult, July; Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Fidia viticida Walsh., grape root worm, adults on grape, 10 May; from **F. M. Webster**, Euclid O. Same on grape leaves, 5 and 7 Aug.; from **J. J. Barden**, Fredonia N. Y.

Oberea bimaculata Oliv., work of raspberry cane-borer, 22 July; from Mrs **H. E. Robinson**, North Nassau N. Y.

Monohammus confusor Kirby, pine sawyer, adult, 19 July; from **W. S. Hammond**, Albany N. Y. Same July; from **C. H. Peck**, North Elba N. Y.

Rhagium lineatum Oliv., ribbed Rhagium, larva under bark of pine, 18 Nov.; from **J. A. Otterson**, Berlin Mass.

Desmocerus palliatus Forst., cloaked knotty horn, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Plagionotus speciosus Say, sugar maple borer, adult, 23 July; from **Jeanette C. Miller**, Aldercreek N. Y.

Cyllene pictus Drury, hickory borer, adults from hickory logs, 15 Ap.; from **Eliza S. Blunt**, Brooklyn N. Y. Same 15 June; from **G. G. Atwood**, Albany N. Y.

Prionus laticollis Drury, broad-necked Prionus, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Allorhina nitida Linn., green June beetle, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Pelidnota punctata Linn., spotted grapevine beetle, adult on Ampelopsis, 15 July; from **J. L. Appleton**, Albany N. Y.

Anomala lucicola Fabr., light-loving grapevine beetle, adults at roots of peachtree, 28 May and July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Lachnosterna fusca Frohl., May beetle, 27 May; from **Eliza S. Blunt**, New Russia N. Y. Larva of same on aster, 23 July; from **L. Menand**, Albany N. Y.

Geotrupes egeriei Germ., adult, 28 May; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Lucanus dama Thunb., stag beetle, adult, 19 July; from Prof. **H. P. Whitlock**, Catskill N. Y.

Ptilinus ruficornis Say, adults in maple and birch flooring, 11 July; from Dr **S. B. Ward**, Saranac Inn N. Y.

Melanotus communis Gyll., common snapping beetle, larva attacking potatoes, Feb.; from **J. C. B.**, Orange county. Same 15 June; from **G. G. Atwood**, Albany N. Y. Same July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Alaus myops Fab., adult, 5 Oct.; from **H. N. Otterson**, Bolton Mass. Same 9 Oct.; from Prof. **F. C. Paulmier**, Rensselaerville lake, N. Y.

Alaus oculatus Linn., owl beetle, adult, 20 June; from **J. Baumgarten**, New York N. Y. Same 24 June; from **J. D. Wasson**, Altamont N. Y. Same 24 June; from **Marie Walker**, Athens N. Y. Same July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y. Same 10 July; from **J. F. Johnson**, Breakabeen N. Y.

Anthrenus verbasci Linn., museum pest, pupae and larvae feeding in stored silk worm cocoons and also strands of spun silk floss, 16 Feb.; from Miss **Jennie Utter**, Albany N. Y. Same adults, 17 Ap.; from **B. F. Koons**, Storrs Ct.

Anthrenus scrophulariae Linn., Buffalo carpet beetle, adults and larval skins on Zanzibar gum, 14 Nov.; from **John Wallace**, Albany N. Y.

Trogoderma ?tarsale Melsh., larval skin from old book, 5 Nov.; from **G. W. Cravens**, Schenectady N. Y.

Attagenus piceus Oliv., black carpet beetle, larva in tea, 9 Feb.; from **B. O. Burgin**, Albany N. Y. Larvae of same in stored silkworm cocoons, etc., 16 Feb.; from Miss **Jennie Utter**, Albany N. Y. Larvae of same found in garments, 26 Ap.; from Prof. **F. C. Paulmier**, Albany N. Y.

Anatis ocellata Linn., 15 spotted ladybug, larvae, pupae on American elm, 27 June; from **M. E. Woodbridge**, Binghamton N. Y. Same 6 July; from **Mary B. Sherman**, Ogdensburg N. Y.

Philonthus aeneus Rossi., adult, in garbage heap, 11 May; from Mrs **F. J. Riggs**, Albany N. Y.

Dytiscus fasciventris Say, two adults in a cistern, 18 Mar.; from **M. G. Thomas**, Schaghticoke N. Y.

Bradycellus rupestris Say, adult, 1901; from **C. A. Otterson**, Berlin Mass.

Harpalus pennsylvanicus DeG., Pennsylvania ground beetle, adult, 7 June; from **Marguerite Riggs**, Albany N. Y. Same 1901; from **C. A. Otterson**, Berlin Mass.

Harpalus erraticus Say, 27 May; from **Eliza S. Blunt**, New Russia N. Y.

Agonoderus pallipes Fabr., adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y. Same 1901; from **C. A. Otterson**, Berlin Mass.

Calosoma calidum Fabr., fiery hunter, adult, 15 June; from **M. B. Sherman**, Ogdensburg N. Y.

Calosoma scrutator Fabr., searcher, adult, 7 June; from **F. J. Riggs**, Albany N. Y.

Cicindela punctulata Fabr., adult, 8 Feb.; from Dr **J. S. Smith**, Troy N. Y.; from Kansas.

Cicindela repanda Dej., repand tiger beetle, adult, 29 May; from **Eliza S. Blunt**, New Russia N. Y.

Cicindela formosa Say, adult, 8 Feb.; from Dr **J. A. Smith**, Troy N. Y.; from Kansas.

Cicindela audubonii Lec., adult, 8 Feb.; from Dr **J. A. Smith**, Troy N. Y.; from Kansas.

Cicindela pulchra Say, adult, 8 Feb.; from Dr **J. A. Smith**, Troy N. Y.; from Kansas.

Tetracha carolina Linn., adult, 8 Feb.; from Dr **J. A. Smith**, Troy N. Y.; from Kansas.

Diptera

Melophagus ovinus Linn., sheep tick, adult, 1901; from **C. A. Otterson**, Berlin Mass.

Rhagoletis cingulata Loew., cherry fruit fly, adults and puparia on cherries, 24 July; from **J. F. Hunt**, Kendaia N. Y.

?Phorbia fusciceps Zett., fringed anthomyian, work on seedling beans, 7 July and 1 Aug.; from **J. F. Rose**, South Byron N. Y.

Pegomyia affinis Stein., from **J. M. Aldrich**, Moscow, Idaho; from Algonquin Ill.

Stomoxys calcitrans Linn., stable fly on window, 22 Nov.; from Mrs **F. J. Riggs**, Albany N. Y.

Sarcophaga? sp., flesh fly, adult, 14 Sep.; from **W. C. Hitchcock**, Pittstown N. Y.

Cuterebra cuniculi? Clark, the rabbit botfly, larva from a kitten, 19 Aug.; from **D. T. Meskil**, Highland Falls N. Y. Same from Belgian hare, 8 Aug.; from **Fred Harris**, New York.

Hypoderma lineata Villers, warble fly, nearly full grown larvae on cattle, 13 Ap.; from **G. S. Graves**, Newport N. Y.

Eristalis tenax Linn., drone fly, pupae in water, 9 July; from **S. T. Hudson**, Riverhead N. Y.

Tabanus reinwardtii Wied., adult, June 5; from Dr **J. Benton Tipton**, Albany N. Y. Same 10 June; from **Charles Heindel**, Albany N. Y.

Chrysops excitans Walk., adult, 5 June; from Dr **J. Benton Tipton**, Albany N. Y.

Bibio albipennis Say, white winged Bibio, adults on herbage, 29 May; from **Eliza S. Blunt**, New Russia N. Y.

Rhabdophaga salicis Schrk., pupae, adults on basket willow, 1 June; from **H. C. Peck**, Rochester N. Y.

Cecidomyia destructor Say, Hessian fly, pupae on grain, 5 and 11 June; from **C. H. Stuart**, Newark N. Y. Same on wheat, 13 June; from **J. F. Hunt**, Kendaia N. Y. Same on wheat 17 or 18 June; from Mrs **A. M. A. Jackson**, Belle Isle N. Y.

Lepidoptera

Basilarchia archippus Cram., viceroy, 2d stage larva on apple, 19 July; from **P. L. Huested**, Highland N. Y.

Phyciodes tharos Drury, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Eugonia j-album Bd.-Lec., Compton tortoise, adult, 21 Aug.; from **G. S. Graves**, Newport N. Y.

Euvanessa antiopa Linn., spiny elm caterpillar, larva on willow, 17 Sep.; from **G. S. Graves**, Newport N. Y.

Cyaniris ?pseudargiolus Bd.-Lec., larva on apple, 4 June; from **Harriet W. Smith**, North Hector N. Y.

Jasoniades glaucus Linn., tiger swallowtail, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Heraclides cresphontes Cram., giant swallowtail, 3 larvae on prickly ash, July 8; from **P. W. King**, Athens N. Y. Same on fraxinella, 12 July; from **C. A. Deyo**, Schoharie N. Y. Same on orange, 16 July; from **Virgil Bogue**, Albion N. Y. Same on hop hornbeam, July; from Gen. **J. H. Patterson**, Selkirk N. Y. Adult of same, 23 Aug.; from Mrs **Abram Lansing**, Albany N. Y. Larva of same on fraxinella, 11 Sep.; from **Alice G. Fisher**, Batavia N. Y. Same on Dictamnus fraxinella, 17 Sep.; from **O. A. Lansing**, Albany county.

Papilio polyxenes Fabr., black swallowtail, larva on caraway, 3 July; from **G. S. Graves**, Newport N. Y.

Amphion nessus Cram. adult, 12 June; from **O. Q. Flint**, Athens N. Y.

?Thyreus abbotii Swain., the abbot sphinx, young larva on ampelopsis, 15 July; from **R. Thompson**, Ballston Spa N. Y.

Deilephila lineata Fabr., the white lined sphinx, adult on flowers, 26 Aug.; from **F. L. Lill**, East Bethlehem N. Y.

Philampelus pandorus Hübn. pandorus sphinx; larva (parasited) on ampelopsis, 9 Sep.; from **Cyrus R. Crosby**, Cranberry Creek N. Y.

Ampelophaga myron Cram., green grapevine sphinx, larva on grapevine, 10 July; from **T. W. King**, Athens N. Y.

Same on Virginia creeper, 11 Aug.; from **Jeanette C. Miller**, Aldercreek N. Y.

Phlegethontius celeus Hübn., tomato or potato worm, pupa in soil, 9 May; from **G. F. Bixby**, Plattsburg N. Y. Same 23 May; from **G. S. Graves**, Newport N. Y.

Phlegethontius carolina Linn., tobacco worm, larva on potato, 18 July; from **C. C. Hardenbergh**, Stoneridge N. Y.

Alypia octomaculata Hübn., eight spotted forester, larva on Virginia creeper, 22 July; from Mrs **H. E. Robinson**, North Nassau N. Y. Same 30 July; from **Jeanette C. Miller**, Aldercreek N. Y.

Arctia virguncula Kirby, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Spilosoma virginica Fabr., yellow woolly bear, adult in spider's web, 15 July; from **G. S. Graves**, Newport N. Y. Same 15 July; from **W. C. Hitchcock**, Pittstown N. Y. Same July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Hyphantria cunea Drury, fall webworm, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y. Same on catalpa, 27 Aug.; from **C. L. Allen**, Floral Park N. Y. Same 5 Sep.; from **Hiram Van Slyke**, Coxsackie N. Y. Same on many trees and shrubs, 5 Sep.; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Notolophus ?antiqua Linn., egg on apple, 11 May; from **B. D. Van Buren**, Plattsburg N. Y.

Notolophus leucostigma Abb. & Sm., white marked tussock moth, male, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y. Same, female and recently laid eggs, 2 Oct.; from **M. W. Van Denburg**, Mount Vernon N. Y. Larvae were abundant the last three weeks of September, the females beginning to spin up the last week of September.

Sibine stimulea Clem., saddle back caterpillar, larvae, 24 Aug.; from **O. Q. Flint**, Athens N. Y. Same on beet leaves, 17 Sep.; from **J. B.**, Greenwich Ct.

Datana ministra Drury, yellow necked appletree caterpillar, larvae on quince, 10 Aug.; from **C. H. Peck**, Menands N. Y.

Datana integerrima Gr. & Rob., larvae on walnut, 6 Aug.; from **Washington Rodman**, Astoria N. Y. Same larvae and pupae on hickory 13 and 21 Aug.; from **B. F. Koons**, Storrs Ct. Same 31 Aug.; from **Leigh I. Holdredge**, Oneonta N. Y.

Schizura concinna Abb. & Sm., red humped appletree worm, larva on apple 22 July; from Mrs **H. E. Robinson**, North Nassau N. Y. Same 30 July from **H. D. Lewis**, Annandale N. Y.

Samia cecropia Linn., cecropia moth, adult, 21 June; from **Mary B. Sherman**, Ogdensburg N. Y. Same 2 July; from **Minnie Green**, Albany N. Y.

Automeris io Fabr., io moth, adult, 13 June; from **J. P. Van Ness**, East Greenbush N. Y. Same larva, 23 July; from **Harriet M. Smith**, North Hector N. Y. Same larvae on apple, 26 July; from **V. P. D. Lee**, Altamont N. Y.

Anisota senatoria Abb. & Sm., orange striped oak worm, larva dead on pin oak (Quercus palustris) 30 Aug.; from **L. Menand**, Albany N. Y.

Clisiocampa americana Fabr., appletree tent-caterpillar, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y. Same, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Clisiocampa disstria Hübn., forest tent-caterpillar, larvae on apple, 11 May; from **G. F. White**, Preston Hollow N. Y. Same, larva, on elm 30 May; from **Rhoda Thompson**, Ballston Spa N. Y. Same, cocoons, 30 July; from **H. D. Lewis**, Annandale N. Y.

Tolype laricis Fitch, larch lappet caterpillar from under a plumtree, 30 July; from **J. H. Clark**, Coldwater N. Y.

Prionoxystus robiniae Peck, oak carpenter moth, larvae in sugar maples, 1 Dec.; from **Mary B. Sherman**, Ogdensburg N. Y. Over 20 half and full grown larvae were taken from one tree. Same, larvae in ash trunk, 8 June and adults, 28 June; from **M. F. Adams**, Buffalo N. Y.

Zeuzera pyrina Fabr., leopard moth, larva in imported quince seedlings, 29 Jan.; from **C. H. Stuart**, Newark N. Y.

Mamestra picta Harr., zebra caterpillar, larvae on red raspberry, 20 June; from **F. J. Hunt**, Kendaia N. Y.

Hydroecia nitela Guen., stalk-borer, larva on raspberry, 17 July; from Mrs **H. E. Robinson**, North Nassau N. Y.

Euthisanotia grata Fabr., beautiful wood nymph, moth, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Plusia balluca Geyer, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Plusia simplex Guen., celery plusia, larvae on celery, 14 Oct.; from **L. Balderston**, Colora Md.

Catocala amatrix Hübn., adult, 14 Sep.; from **W. C. Hitchcock**, Pittstown N. Y.

Paleacrita vernata Pack., spring canker worm, eggs, larvae on appletree, 6 May; from **J. F. Hunt**, Kendaia N. Y. The eggs were just hatching, and the living female received deposited a number of eggs.

Alsophila pometaria Harr., fall canker worm, larvae on apple, 15 May; from Mrs **A. M. A. Jackson**, Belle Isle N. Y.

Evergestis stramenalis Hübn., black headed cabbage worm, larva on turnip, 3 and 13 July; from **G. S. Graves**, Newport N. Y.

Plodia interpunctella Hübn., Indian meal moth, all stages in a box of roasted oats, 18 Feb.; from Mrs **F. J. Riggs**, Albany N. Y.

Cacoecia ?rosaceana Harr., oblique banded leaf-roller, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y. Same, larvae on maple, 6 Aug.; from **Hugh P. Blackinton**, Hoosick Falls N. Y.

Tmetocera ocellana Schiff., bud moth, larvae on apple, 15 May; from Mrs **A. M. A. Jackson**, Belle Isle N. Y.

Phoxopteris nubeculana Clem., apple leaf-folder, larva on apple, 27 Oct.; from **J. Jay Barden**, Fredonia N. Y.

Carpocapsa pomonella Linn., codling moth, larva on quince, 12 July; from **S. B. Strong**, Setauket N. Y.

Sitotroga cerealella Oliv., grain moth, all stages in a cereal, 11 Mar.; from **Albany camera club**, Albany N. Y.

Ornix geminatella Pack., mines in apple leaves, 29 Oct.; from **J. Jay Barden**, Fredonia N. Y. They were so abundant that there was scarcely a perfect leaf in the orchard.

Coleophora malivorella Riley, pistol case-bearer, larvae on appletree, 6 May; from **J. F. Hunt**, Kendaia N. Y.

Coleophora limosipennella Dup., larvae on European elm, 15 June; from **E. T. Schoonmaker**, New York N. Y

?Catastega aceriella Clem., work of larvae on hard maple, 13 Aug.; from **Jeanette C. Miller**, Aldercreek N. Y.

Lithocolletis pomifoliella Zell., thorn apple leafminer, mines in apple leaves, 29 Oct.; from **J. Jay Barden**, Fredonia N. Y.

Bucculatrix canadensisella Cham., birch leaf Bucculatrix, larvae and pupae very abundant on birch, 3 Sep.; from **Mrs H. D. Graves**, Ausable Forks N. Y. Same, larvae on white birch, exceedingly abundant, 11 Sep.; from **Mary B. Sherman**, Ogdensburg N. Y.

Mecoptera

Panorpa confusa Westw., scorpion fly, adults taken at Sandusky O., 29 June; from **J. S. Hine**, Columbus O.

Panorpa venosa Westw., scorpion fly, adults taken at Hanging Rock O., 27 June; from **J. S. Hine**, Columbus O.

Bittacus punctiger Westw., adults, taken in District of Columbia, 18 July; from **J. S. Hine**, Columbus O.

Bittacus apicalis Uhl., adults taken at Sandusky O., 12 July; from **J. S. Hine**, Columbus O.

Neuroptera

Chauliodes pectinicornis Linn., adults, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Corydalis cornuta Linn., horned Corydalis, adult, 5 July; from **F. S. Tinney**, Albany N. Y. Same, 10 July; from **A. T. Laird**, Albany N. Y. Same, adult, 15 July; from **A. H. Green**, Shushan N. Y. Same, adult, 15 July; from **H. D. Lewis**, Annandale N. Y.

Hemiptera

Acanthosoma cruciata? Say, last nymphal stage, on hemlock, 20 Aug.; from **Eliza S. Blunt**, summit of Mt Hurricane, N. Y.

Anasa tristis DeGeer, squash bug, eggs, adults on squash, 29 June; from Schoharie county. Same, 10 July; from **Rhoda Thompson**, Ballston Spa N. Y.? Work of same and first nymphal stage, on squash or melon, 15 Aug.; from Mrs **C. C. Woolworth**, Castleton N. Y. Nymph of same, 19 Aug.; from **George S. Graves**, Newport N. Y.

Blissus leucopterus Say, chinch bug, adult on timothy, 7 Sep.; from **James M. Graff**, Westport N. Y.

Leptopterna dolobrata Linn., adults, on wheat, 27 June; from **C. H. Stuart**, Newark N. Y.

Lygus pratensis Linn., tarnished plant bug, 8 Sep.; from Miss **Eliza S. Blunt**, New Russia N. Y.

Poecilocapsus lineatus Fabr., four lined leaf bug, adults on chrysanthemum, 26 June; from **E. T. Schoonmaker**, Cedar Hill N. Y.

Triphleps insidiosus Say, 8 Sep.; from Miss **Eliza S. Blunt**, New Russia N. Y.

Acanthia lectularia Linn., bed bug, adult, 19 Feb.; from **John Wallace**, Albany N. Y.

Phymata wolffii Stal., ambush bug, adult, 12 Aug.; from **G. A. Baily**, Cardiff N. Y.

Emesa longipes DeGeer, thread legged bug, adult, 16 Sep.; from **O. Q. Flint**, Athens N. Y.

Benacus griseus Say, giant water bug, adult, 17 June; from Mrs **M. B. Witherell**, Shushan N. Y.

Typhlocyba comes var. vitis Harr., grapevine leaf hopper, cast skins on grape leaves, 15 Nov.; from **Alice M. Gardner**, Fulton N. Y.

Poeciloptera septentrionalis Spin., grape Poeciloptera, adult accidentally on celery, 14 Oct.; from **L. Balderston**, Colora Md.

Ormenis pruinosa Say, lightning leaf hopper, young on pear, currant, ? plantain, 10 July; from **G. S. Clark**, Milton N. Y. Nymph of same on grape, 24 July; from **J. F. Hunt**, Kendaia N. Y.

Enchenopa binotata Say, two spotted tree hopper, adults on bittersweet, 30 July; from Dr **Henry Coffin**, Glens Falls, N. Y.

Haematopinus eurysternus Nitzs., short-nosed cattle louse, eggs and adults on cattle hairs, 6 Feb.; from Dr **C. D. Smead** Ohio.

Phylloxera caryaecaulis Fitch, hickory gall aphis, all stages in hickory galls, 8 June; from **H. N. Howe**, Bedford Station N. Y.

Phylloxera vitifoliae Fitch, grape Phylloxera, galls on grape leaves, 7 Sep.; from Miss **M. L. Williams**, Sherburne, N. Y.; adults and young of same in grape galls, 27 Sep.; from **J. Jay Barden**, Fredonia N. Y.

Pemphigus tessellatus Fitch, alder blight, on German alder (imported) and the native species 24 June; from **H. C. Peck**, Rochester N. Y.

Schizoneura americana Riley, woolly elm aphis, young and adults on American elm, 30 May; from **Rhoda Thompson**, Ballston Spa N. Y.

Phyllaphis fagi Linn., beech aphis, on red beech, 20 June; from Mrs **C. J. Gould**, Tarrytown N. Y.

Callipterus ulmifolii Monell, elm leaf aphis, exuviae on American elm, 27 June; from **M. E. Woodbridge**, Binghamton N. Y. Same 15 June; from **A. H. Wright**, Rome N. Y.

Myzus cerasi Fabr., cherry aphis, all stages on cherry, 12 June; from **C. A. Wieting**, Cobleskill N. Y.

Myzus ribis Linn., currant aphis, females on currant, 4 May; from **L. I. Holdredge**, Oneonta N. Y. Young of same, 1 June; from **J. B. Rice**, Cambridge N. Y. Same, 12 June; from **C. A. Wieting**, Cobleskill N. Y.

Chionaspis euonymi Comst., on Celastrus scandens, 20 Dec.; from **P. L. Huested**, Blauvelt N. Y.

Chionaspis furfura Fitch, scurfy bark louse, adults and eggs on baldwin apples (fruit), 24 Nov.; from ? **C. J. Lisk**, New Baltimore N. Y.

Chionaspis ?lintneri Comst., on Cornus, 19 Mar.; from **H. C. Peck**, Rochester N. Y. Probably same, 15 Sep.; from **P. L. Huested**, Buffalo N. Y.

Chionaspis pinifoliae Fitch, pine leaf scale insect, adults on white pine needles, 30 Oct.; from **Spencer Trask**, Saratoga Springs N. Y.

Mytilaspis pomorum Bouché, appletree bark louse, eggs under scales on Pennsylvania maple, 10 Feb., eggs of same on Crataegus, 1 June, and young on apple, 8 June; all from **G. S. Graves**, Newport N. Y. Eggs of same on apple, 15 Ap.; from **C. E. Childs**, Mayfield, N. Y. 4 May; from **W. M. Phipps**, Albion N. Y. 9 May; from **Cyrus Crosby**, Cranberry Creek N. Y. Eggs of same on lilac, 9 May; from **C. A. Hall**, Oak Hill N. Y. Probably same on syringa imported from Germany, 24 June; from **H. C. Peck**, Highland park, Rochester N. Y. Same on ash, 30 Aug.; from **J. T. Gaylord**, Poughkeepsie N. Y.

Parlatoria viridis Ckll., on Japanese maple, 26 Ap.; from **H. C. Peck**, Rochester N. Y.

Aulacaspis rosae Sandb., rose scale, on blackberry, 27 Mar.; from **J. Jay Barden**, Stanley N. Y. Same with eggs, on black raspberry, 10 May; from **William Trimble**, Concordville Pa. Same on blackberry, 3 June; from Hudson N. Y.

Diaspis cacti Comst. cactus scale, all stages on night blooming cereus, Cereus grandiflora, 7 Nov; from **L. H. Joutel**, New York N. Y.

Aspidiotus ancylus Putn., Putnam's scale, on nectarine and pear, 10 May; from **Edward Moore**, Loudonville N. Y. Same on apple, 24 June; from **B. D. Van Buren**, Union Springs N. Y. Same, adults and young on purple-leafed beech, 26 July; from **P. L. Huested**, Menands N. Y. Same on mountain ash, 6 Aug. from **H. C. Peck**, Rochester N. Y.

Aspidiotus forbesi Johns., cherry scale on Japan plum, 10 June; from **D. C. Lee**, Cornwall N. Y. Same on apple, 30 Aug.; from **P. L. Huested**, Crescent Station N. Y.

Aspidiotus ostreaeformis Curt., English fruit tree scale insect, on apple, 6 June; from **B. D. Van Buren**, Union Springs N. Y. Same with probably some A. ancylus on currant, 15 June; from **C. H. Darrow**, Geneva N. Y. Adult female of same, on ? willow and ? plum, 16 July from **Mr Van Buren**, Scipioville N. Y. Adults and young of same on willow, 20 July, and adults of same, on Carolina poplar, 5 Aug.; from **J. Jay Barden**, Fredonia N. Y. Same on plum, 6 Aug.; from **H. C. Peck**, Rochester N. Y.

Aspidiotus perniciosus Comst., San José scale, breeding on peach, 19 Oct.; from **E. M. Wilson**, Babylon N. Y. Same on Japan plum, 27 Nov.; from **A. M. Halstead**, Rye N. Y. Young of same on plum, 25 Feb.; from Dr **Edward Moore**, Loudonville N. Y. Young of same on apple, 29 Ap.; from **J. A. Hepworth**, Marlboro N. Y. 13 July; from **L. L. Morrell**, Kinderhook N. Y. Same on Japan quince, 6 May; from **J. A. Paine**, New York N. Y. Same, half grown, on flowering prune, 8 June; from **H. N. Howe**, Bedford Station N. Y., through *Country gentleman*. Same on Japan plum, 17 June; from **L. F. Brown**, near Highland N. Y.

Aspidiotus uvae Comst., on grapevine, 26 Mar.; from **J. L. Cooper**, Nashville Tenn., through *Country gentleman*.

Asterolecanium variolosum Ratz., golden-oak scale, on white oak, 16 Sep.; from **I. O. C.**, Yonkers N. Y., through *Country gentleman*.

Lecanium cerasifex Fitch, cherry Lecanium on apple, 25 Mar.; from **M. H. Beckwith**, Elmira N. Y.

Lecanium hesperidum Linn., young and adults on fern, 22 Mar.; from **J. D. Winne**, Kingston N. Y. Same on orange, 19 Aug.; from **J. W. Knapp**, Warwick N. Y.

Lecanium ? prunastri Fonsc., New York plum Lecanium, young on plum, 13 Ap.; from **M. H. Beckwith**, Elmira N. Y. 22 June; from **C. H. Darrow**, Geneva N. Y.

Gossyparia ulmi Geoff., Elm bark louse, adult on elm, 17 June; from **H. C. Peck**, Rochester N. Y.

Orthoptera

Oecanthus niveus DeGeer, white flower cricket, eggs in raspberry canes, 31 Dec.; from **C. G. Babcock**, Newport N. Y. Eggs of same in peach twigs, 7 Feb.; from **H. C. Peck**, Scottsville N. Y. Adult of same, 14 Sep.; from **W. C. Hitchcock**, Pittstown N. Y.

Microcentrum retinervis Burm., angular winged katydid, eggs, on plum, 18 June; from Austin W. Va., through **Vick publishing co.** Rochester N. Y.

Diapheromera femorata Say, walking stick, adult, 26 Oct.; from **Harry W. Riggs**, Albany N. Y.

Mantis religiosa Linn., praying mantis, 127 egg cases on grass stalks, etc., 8 Ap.; from **H. F. Atwood**, Rochester N. Y.

Ischnoptera pennsylvanica DeGeer, wood cockroach, young in decayed wood, 31 Jan.; from **Henry L. Griffis**, Newpaltz N. Y.

Nyctoboro ?holosericea Klug., young probably on bananas, 13 Ap.; from **J. M. Dolph**, Port Jervis N. Y.

Corrodentia

Psocus venosus Burm. on maple, 13 Aug.; from **B. F. Koons**, Storrs Ct.

Thysanura

Thermobia furnorum Rov., silver fish, adult among papers, etc., 5 Nov.; from **G. W. Cravens**, Schenectady N. Y.

Smynthurus hortensis Fitch, garden flea, adults on melon and squash, 31 May; from **C. E. Ford**, Oneonta N. Y.

Arachnida

Phytoptus ulmi Garm., elm gall mite on American elm, 8 June; from **G. S. Graves**, Newport N. Y.

Appendix

ACCOUNT AND CATALOGUE OF THE ENTOMOLOGIC EXHIBIT AT THE PAN-AMERICAN EXPOSTION 1901

Official awards

Gold medal. Collective exhibit of insects

Silver medals. Forest and shade tree insects; entomologic technical collection; wing frame exhibit showing work of entomologist.

Several things were kept in mind in the preparation of this collection. It was designed primarily to be of the greatest possible value to all those who are obliged to control insects or suffer financial loss; and, to accomplish this, insects injurious to the different crops and to various products were given a very prominent place in the exhibit. These injurious species are also represented, so far as possible, in their different stages, egg, larva, pupa and adult, and any peculiarities of habit (specially those bearing on the character of the injury) are illustrated. Thus in looking over the exhibit of injurious forms, the visitor has before him an epitome of the life of the depredator. He sees not only the insect in its injurious stage but also in its other forms, and in a few moments he can grasp many of the essential facts in the life history of a pest. The illustrations of the work of the injurious species are frequently very helpful in enabling a farmer to recognize the author of what was to him previously a mysterious injury. A catalogue of the collection was also prepared, and its value much enhanced by the addition of references to the principal notices of economic groups and also of individual species, thus making it practically a reference book to the latest and most accessible accounts of the various pests represented, and, in addition to

this, brief directions are given for controlling the various forms. The enormous number of injurious insects, even in New York state, made it imperative that the exhibit should be limited to the more important forms, and that the insects selected be grouped in a manner easily comprehended by the general public; they are therefore arranged under various important food plants, etc., and each group receives special notice under an appropriate head.

There are many who are interested in insect life for other than economic reasons. Students of entomology will find much of interest in the systematic collection, in which are native representatives of all the more important families, and beginners will derive much aid in the care of their specimens from a study of the technical collection. Those attracted by the peculiar or beautiful in nature will find much of interest in the collection of the work of gall insects, in the mimicry collection and in the collection of New York beauties, the latter being an assemblage of some of the more beautiful native butterflies and moths. The wing frames and framed photographs present by means of statistics and illustrations some of the more important activities of the office. The entire exhibit can now be seen at the state museum, Albany N. Y.

Fruit tree insects (nos. 1-23). This collection of 23 different species includes some of the most important insect enemies of man, such as the codling moth, a species causing an estimated annual loss in New York state alone of about $3,000,000, the plum curculio, appletree borers (both exceedingly destructive), rose beetle, appletree tent-caterpillar, case-bearers and others, all insects causing much loss annually to fruit growers. Many of these pests have been repeatedly noticed in the reports and bulletins issued by the state entomologist, and, for excellent accounts of individual species, the reader is referred to the citations given in the appended catalogue.

Vine and small fruit insects (nos. 24-41). This group comprises 18 of the most injurious forms depredating on the grapevine, currant, raspberry and other small fruits. One of the most important species represented is the grapevine root worm, a

beetle which has already caused considerable loss in the western part of the state and one which threatens to do much injury in the future. The grapevine flea beetle is another pest which demands special mention in this connection. The grapevine plume moth, the currant sawfly and the tarnished plant bug are all familiar in a way to many growers, and yet few comprehend fully the actual mischief they cause. Many of those included in this and following groups have been figured and briefly described in bulletin 37 of the New York state museum.

Garden insects (nos. 42-68). This group is represented by 27 species which injuriously affect one or more of the crops commonly grown in gardens. In it are found such notorious pests as wireworms, cutworms, cabbage butterfly, blister beetles, cucumber beetles, flea beetles, asparagus beetles, squash bugs, etc. Many of them are very common, and not a few are exceedingly destructive, in spite of the fact that in most cases there are a number of well-known methods of keeping these pests in control. Most of these forms are treated of in the reports of the state entomologist, and many of them in the state museum bulletin 37, cited above.

Grass and grain insects (nos. 69-83). This group contains only 15 species, but in it are represented some exceedingly destructive insects. The June beetles, or white grubs, are probably as destructive as some of the species feared much more, but, as the injury they cause is usually a constant one, it attracts little attention as a rule. The army worm outbreak of 1896 is still fresh in the minds of many, while the Hessian fly has this year caused an estimated loss in New York of $3,000,000, or about half the crop. The chinch bug is another of the notorious enemies to prosperity, proving most injurious in the southern and western states, though in 1882 and 1883 it threatened to cause considerable loss in New York state. A very good account of this outbreak is given by the late Dr Lintner in his second report as state entomologist. A number of species of grasshoppers are also included, since they not infrequently cause great mischief in various sections of the state.

Household insects (nos. 84-99). The species represented in this group are but 16 in number, yet many a housewife would prefer to fight two or three less prolific pests, rather than any one of several which may be named in the list. Recent investigations have shown that not only is the common house fly a nuisance about the house, but also that it is a menace to the good health of the community. A reduction of its numbers is comparatively easy. The cheese skipper, noticed in detail in the 12th report of the state entomologist, is of much interest to cheese makers. The croton bug, cockroach, carpet beetles, clothes moths and other familiar pests in the home have been treated briefly by the state entomologist in the transactions of the New York state agricultural society for 1899.

Insects affecting stored food products (nos. 100-8). This small group, comprising but nine species, includes some very injurious forms. The most important are, the grain moth (a species which has caused considerable injury to wheat on Long Island and adjacent localities last year and this), the bean weevils and the cigarette beetle. Most of these insects breed readily in various dried food products and not infrequently they are sources of annoyance in the house. Most of these species have been briefly treated in bulletin 37 of the New York state museum.

Beneficial insects (nos. 109-63). This is an exceedingly important group which is represented in the collection by 55 different species. A series of forms which carry pollen from one plant to another is shown in order to emphasize this function of insects. It may well be considered as one of the most important exercised by them. A few of the many beneficial parasites and predaceous enemies of insects are included, so that the farmer and others may have some idea of the appearance of beneficial forms. The mulberry silkworm and some of its allies comprise the portion of this group devoted to species of direct value or benefit to man.

Scale insects, Coccidae (nos. 164-202). This exceedingly important group differs so widely from all other insects that its

members were brought together in one collection, that the comparative differences between them might be more easily seen. The 39 species represented include, among others, the two very common and injurious forms known as the appletree bark louse and the scurfy bark louse. The notorious San José scale insect is well represented, and its close allies, the English fruit tree scale insect, the cherry scale insect and Putnam's scale insect, also find a place in the collection. These more important enemies of fruit trees have been treated of in considerable detail and admirably illustrated in colors in bulletin 46 of the New York state museum. Another very important scale insect included here is the elm bark louse, a species which is noticed in some detail and illustrated in colors in the 5th report of the fisheries, game and forest commissioners of New York.

Forest insects (nos. 203-51). This very important group is represented in the collection by 49 species, the result mostly of recent collections made in the state. Dr A. D. Hopkins, who is a recognized authority on this subject, estimates the total annual loss caused by insects in this country in forest and forest products at the enormous sum of $25,000,000. This is a group to which comparatively little attention had been paid in New York till the state entomologist took up the study of it several years ago. Among the more important forms represented in this collection may be mentioned the pine "sawyer," a large grub which frequently causes much injury to logs allowed to lie for some time in mill yards. A number of species of bark-borers are represented. They are of special interest, because several of them are quite injurious to soft woods in the Adirondacks, while other species are killing pine in the Hudson river valley and on Long Island. The forest tent-caterpillar, the pest which has been ravaging our hard maples in recent years, is well represented in the collection, along with some of its natural enemies. A summary account of this insect, illustrated by colored figures, has been given by the state entomologist in the 4th report of the fisheries, game and forest commissioners of New York.

Shade tree insects (nos. 252-67). This group, illustrated by 16 species, naturally comes very close to the preceding. It has been limited largely in the present instance to those species which are rarely of economic importance except when attacking shade trees; and, as these are among our most valuable assets, the group is of great economic importance. It includes such destructive pests as the sugar maple borer, leopard moth, elm bark borer, elm bark louse, elm leaf beetle, white marked tussock moth, bag worm, and others, all very injurious to highly prized shade trees. Most of them can be controlled without excessive expense. For detailed accounts of these pests the reader is referred to the New York state museum bulletins 20 and 27, to the 12th report of the state entomologist and to his papers in the 4th and 5th reports of the fisheries, game and forest commissioners of New York.

Work of gall insects (nos. 268-97). This is a small collection of deformities produced in plants by 30 species of insects belonging to three different orders. It illustrates the effect a comparatively insignificant insect may have on plant tissues, and in the study of the collection a number of interesting biologic problems are presented to the mind of the student.

Systematic collection (nos. 298-931). This assemblage of 634 species occupies nearly one third of the entire space devoted to the display of insects. It is arranged according to what are believed to be the natural affinities of the species. That is, the more closely related are put next to each other, so far as possible. There is nothing very new in the collection, but it accomplishes its object in giving the casual observer some idea of the immense number and variety of forms found in the insect world. Such a collection can make no pretense to completeness, as will be seen at once, when it is remembered that our best authorities estimate that between one and 10 million different species of insects now exist in the world. It has special value, however, to residents of New York state, since the more common native forms are very fully represented. This is of particular advantage in showing to some extent how many insects occur in a locality,

and the sight of these should serve as a stimulus to the young collector. This part of the exhibit should also aid materially in the identification of native forms by comparison. The common names of orders, families, groups and species, where well recognized ones occur, have received a prominent place, so that the nonscientific may not be discouraged by labels bearing only unfamiliar Latin names, and those who will use only scientific names, will find them readily, even though written in smaller characters. A more definite idea of this collection may be obtained by the following figures. The bee and the wasp family is represented by 67 species, beetles, by 213 species, two winged flies (Diptera) by 55 species, butterflies, by 69 species, moths, by 106 species, true bugs, by 44 species (to which should be added the 39 species of scale insects put in a special collection) and the grasshopper family, by 20 species. The smaller orders like the fleas, caddis flies, Thrips, white ants, stone flies, dragon flies, May flies, etc., are represented by relatively fewer species. This part of the exhibit contains by far the largest number of species, and, in order to get the most out of it, considerable time should be given to the groups most interesting to the individual observer.

Collection illustrating protective mimicry (nos. 932-46). This is a small lot, comprising but 15 species. It is an exceedingly pretty assemblage of insects, and, though individuals may disagree as to the method by which such interesting adaptations are brought about, no one can fail to admire the collection as a whole and to be interested in the striking illustrations of protective mimicry.

New York beauties (nos. 947-61). This small assemblage of only 15 native species was brought together for the purpose of showing some of the beautiful forms occurring in our state.

Technical collection (nos. 962-1021). This consists of over 60 different articles arranged to show the best methods and apparatus for the collection and preservation of insects. It is an exceedingly important subject to the amateur entomologist; and, as most of the articles exhibited are comparatively inexpensive, and as many homemade devices are included in the collection,

this portion of the exhibit can not fail to be of interest and of great practical value to those making collections of insects.

Framed photographs (nos. 1022-26). This series is largely historical in nature, as enlarged photographs of the two early official entomologists of the state and the residence and work building, or " bug house," of the New York pioneer in economic entomology occupy prominent places in the collection. While all of these are of importance, because the public should be interested in the features of prominent scientific men, the two latter photographs are exceedingly valuable, because they constitute a graphic record of the conditions under which the study of insects was first pursued by a New York state official.

Wing frames (1027-52). The tables and illustrations displayed on the wing frames give a general idea of the main activities of the office. Besides organization, list of publications, table of correspondence, etc., most of the wing frames are occupied with some of the more important original illustrations prepared in the office, thus giving in a graphic manner some idea of the number and variety of insects studied.

Publications. This exhibit includes all of the more important publications of the state entomologist and his predecessor, the entomologist of the New York state agricultural society. The Fitch reports, as they are commonly termed, and the reports of the state entomologist contain many detailed, illustrated notices of our most important insect pests. The entomologic bulletins of the state museum, except a few of the later ones devoted to the report of the entomologist, usually treat of a well related group and are as a rule of more service to the practical, non-entomologic person than independent notices in various reports or in separate bulletins. The reference to the more accessible, important notices of injurious insects listed in the appended catalogue should prove invaluable in directing the general public to the desired information in these reports and bulletins.

A copy of the catalogue is appended to this account and should be consulted for further information in regard to the collection.

CATALOGUE

FRUIT TREE INSECTS (1-23)

General works on the group

Fitch, Asa. Noxious and other insects of New York. 3d rep't, '56. p. 3-119.

Saunders, William. Insects injurious to fruits. Lippincott. Phila. '89. p. 1-436.

Weed, C. M. Insects and insecticides. Published by the author, Hanover N. H. '91. p. 1-281.

Smith, J. B. Economic entomology. Lippincott. Phila. '96. p. 1-481.

1 **Codling moth,** Carpocapsa pomonella Linn. Principal food plants: apple, pear.

Treatment: Spray with poison soon after the petals have fallen, destroy fallen fruit, trap larvae under bands.

Chief accessible articles: **Comstock, J. H.** U. S. dep't agric. Rep't, '79. p. 253-55; **Howard, L. O.** —— '87. p. 88; **Lintner, J. A.,** state ent. 9th rep't, '92. p. 338-42; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 142. '98. p. 1-69; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 276-77.

2 **Bumble flower beetle,** Euphoria inda Linn. Principal food plants: peaches, corn.

Treatment: hand picking.

Chief accessible article: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 232-39.

3 **Plum curculio,** Conotrachelus nenuphar Herbst. Principal food plant: plum.

Treatment: Destroy the beetles after jarring them from the trees.

Chief accessible articles: **Riley, C. V.** and **Howard, L. O.** U. S. dep't agric. Rep't, '88. p. 57; **Lintner, J. A.,** state ent. 7th rep't, '91. p. 288-96.

4 **Pear midge,** Diplosis pyrivora Riley. Principal food plant: pear.

Treatment: Destroy infested fruit before maggots escape.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. Rep't, '85. p. 283-89; **Lintner, J. A.,** state ent. 8th rep't, '91. p. 140-51.

5 Round-headed appletree borer, Saperda candida Fabr. Principal food plant: appletree.

Treatment: Dig out borers, protect trunk with paper or wire netting, use carbolic-soap washes.

Chief accessible articles: Lintner, J. A., state ent. 5th rep't, '89. p. 269-71; Chittenden, F. H. U. S. dep't agric. div. ent. Circ. 32, 2d s. '98. p. 1-8.

6 Flat-headed appletree borer, Chrysobothris femorata Fabr. Principal food plants: apple, pear and plum trees.

Treatment: carbolic-soap washes, digging borers out.

Chief accessible article: Chittenden, F. H. U. S. dep't agric. div. ent. Circ. 32, 2d s. '98. p. 9–12.

6a Peach tree borer, Sanninoidea exitiosa Say. Principal food plant: peach.

Treatment: Apply washes between June 5 and July 1 or use protective bands and supplement by digging out borers.

Chief accessible articles: Fitch, Asa. Noxious and other insects. N. Y. 1st rep't, p. 108-117; Lintner, J. A., state ent. 8th rep't, '91. p. 181-86; Slingerland, M. V. Cornell agric. exp. sta. Bul. 176, '99, p. 192.

7 Pear blight beetle, Xyleborus dispar Fabr. Principal food plant: peartree.

Treatment: Cut and burn infested limbs, keep trees vigorous.

Chief accessible articles: Lintner, J. A., state ent. 7th rep't, '91. p. 348-51; Hubbard, H. G. U. S. dep't agric. div. ent. Bul. 7, n. s. '97. p. 22–23.

8 Fruit tree bark beetle, Scolytus rugulosus Ratz. Principal food plants: peach, plum, cherry trees.

Treatment: Cut and burn badly infested limbs, keep trees vigorous.

Chief accessible articles: Lintner, J. A., state ent. 4th rep't, '88. p. 103–7; Chittenden, F. H. U. S. dep't agric. div. ent. Circ. 29, 2d s. '98. p. 1–8.

9 Rose beetle, Macrodactylus subspinosus Fabr. Principal food plants: fruit trees and rosebushes.

Treatment: Spray beetles with whale oil soap, ½ pound to 1 gallon water, dust plants with plaster, ashes, etc.; hand picking.

Chief accessible articles: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 227–32; **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 11, 2d s. '95. p. 1–4; **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 396–98.

10 **Appletree tent-caterpillar,** Clisiocampa americana Fabr. Principal food plants: wild cherry, appletrees.

Treatment: Collect and destroy egg belts, kill young while in nests, spray with poison in early spring.

Chief accessible articles: **Felt, E. P.**, state ent. 14th rep't (N. Y. state mus. Bul. 23). '98. p. 177–90; N. Y. state mus. Bul. 27. '99. p. 46–48; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 152. '98. p. 281–93; **Beach, Lowe and Stewart.** N. Y. agric. exp. sta. Bul. 170. '99. p. 389–90; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 271–72.

11 Pimpla conquisitor Say, a parasite on the above.

12 **Gipsy moth,** Porthetria dispar Linn. Principal food plants: fruit, oak, maple and other forest trees.

Treatment: Collect and destroy eggs, kill clustered larvae, spray with arsenate of lead.

Chief accessible articles: **Fernald, C. H.** Mass. (Hatch) agric. exp. sta. Special bul. Nov. '89. p. 1–8; **Forbush, E. H.,** and **Fernald, C. H.** Mass. state board agric. Rept's 1892-1900; **Lintner, J. A.**, state ent. 9th rep't, '92. p. 420-26; **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 11, n. s. '97. p. 1-39; **Forbush, E. H.** U. S. dep't agric. div. ent. Bul. 20, n. s. '99. p. 104-7; **Felt, E. P.**, state ent. 16th rep't, '00 (N. Y. state mus. Bul. 36). p. 955-62.

13 **Brown tail moth,** Euproctis chrysorrhoea Linn. Principal food plants: pear, apple, quince.

Treatment: Cut and burn winter nests, spray trees with poison.

Chief accessible articles: **Fernald, C. H.,** and **Kirkland, A. H.** Mass. (Hatch) agric. exp. sta. Special bul. July '97. p. 1-15; U. S. dep't agric. div. ent. Bul. 17, n. s. '98. p. 24-32.

14 **Palmer worm**, Ypsolophus pometellus Harris. Principal food plant: appletree.

Treatment: Spray with poison in early June.

Chief accessible articles: **Fitch, Asa.** Noxious, and beneficial insects N. Y. 1st–2d rep'ts, '56. p. 221–33; **Lowe, V. H.** Rural New Yorker, July 14, '00. 59: 477–78; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 187. '00. p. 81–101; **Felt, E. P.**, state ent. 16th rep't, '00. p. 962–66.

15 **Oblique banded leaf-roller**, Cacoecia rosaceana Harris. Principal food plant: appletree.

Treatment: Spray early with poison.

Chief accessible notice: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 312.

16 **Apple leaf-folder**, Phoxopteris nubeculana Clem. Principal food plant: appletree.

Treatment: Burn infested leaves.

Chief accessible article: **Riley, C. V.** U. S. dep't agric. Rep't, '78. p. 34–35.

17 **Pistol case-bearer**, Coleophora malivorella Riley. Principal food plant: appletree.

Treatment: Spray thoroughly with poison in early spring.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. Rep't, '78. p. 48–49; **Lintner, J. A.**, state ent. 1st rep't, '82. p. 163–67; **Lowe, V. H.** N. Y. state agric. soc. Trans. '96. p. 352–61; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 124. '97. p. 1–16; **Hall, F. H.** N. Y. agric. exp. sta. Bul. 122. '97. p. 1–5; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 122. '97. p. 221–31.

18 **Cigar case-bearer**, Coleophora fletcherella Fern. Principal food plants: apple.

Treatment: Spray thoroughly with poison in early spring.

Chief accessible articles: **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 93. '95. p. 214–30; **Beach, Lowe** and **Stewart**, N. Y. agric. exp. sta. Bul. 170. '99. p. 391–92.

19 **Apple leaf-miner**, Tischeria malifoliella Clem. Principal food plant: appletree.

Treatment: Burn infested leaves.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 160–62.

20 **Resplendent shield-bearer**, Aspidisca splendoriferella Clem. Principal food plant: appletree.

Treatment: Spray in winter or early spring with contact insecticides.

Chief accessible article: **Comstock, J. H.** U. S. dep't agric. Rep't, '79. p. 210-13.

21 **Apple leaf Bucculatrix**, Bucculatrix pomifoliella Clem. Principal food plant: appletree.

Treatment: Spray with poison in early June.

Chief accessible article: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 157-62.

22 **Bud moth**, Tmetocera ocellana Schiff. Principal food plant: appletree.

Treatment: Spray with poison in early spring.

Chief accessible articles: **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 50. '93. p. 1-29; ——— ——— Bul. 107. '96. p. 57-66; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 397-98.

23 **Pear psylla**, Psylla pyricola Forst. Principal food plant: pear tree.

Treatment: Spray with kerosene emulsion in early spring.

Chief accessible articles: **Lintner, J. A.**, state ent. 9th rep't, '92. p. 317-29; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 44. '92. p. 161-86; ——— ——— Bul. 108. '96. p. 69-81; **Marlatt, C. L.** U. S. dep't agric. div. ent. Circ. 7, 2d s. '95. p. 1-8.

VINE AND SMALL FRUIT INSECTS (24-41)

For general works, *see* those cited under fruit tree insects.

24 **Grapevine root worm**, Fidia viticida Walsh. Principal food plant: grapevine.

Treatment: Spray with poison the latter part of June; keep soil pulverized and mounded about the base of vines in July.

Chief accessible articles: **Webster, F. M.** O. agric. exp. sta. Bul. 62. '95 p. 77-95; **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 391-93; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 184. '00. p. 21-32.

25 **Spotted grapevine beetle,** P e l i d n o t a p u n c t a t a Linn. Principal food plant: grapevine.

Treatment: hand picking.

Chief accessible notice: **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 15.

26 **Light-loving grapevine beetle,** A n o m a l a l u c i c o l a Fabr. Principal food plant: grapevine.

Treatment: hand picking, dusting vines with ashes, plaster, etc.

Chief accessible article: **Lintner, J. A.,** state ent. 10th rep't '94. p. 408-10.

27 **Grapevine flea beetle,** H a l t i c a c h a l y b e a Ill. Principal food plant: grapevine.

Treatment: Spray vines with poison.

Chief accessible articles: **Comstock, J. H.** U. S. dep't agric. rep't, '79. p. 213–16; **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 395–96; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 150. '98. p. 263–65; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 157. '98. p. 189–213.

28 **8 spotted forester,** A l y p i a o c t o m a c u l a t a Fabr. Principal food plants: Virginia creeper, grapevine.

Treatment: Spray with arsenical poisons.

Chief accessible article: **Lintner, J. A.,** state ent. 5th rep't, '89. p. 179-83.

29 **Grapevine plume moth,** O x y p t i l u s p e r i s c e l i d a c t y l u s Fitch. Principal food plant: grapevine.

Treatment: hand picking; spray with poison.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 1st-2d rep'ts, '56. p. 139-43; **Lintner, J. A.,** state ent. 12th rep't, '96. p. 218-22.

30 **Grapevine leaf-hopper,** T y p h l o c y b a c o m e s Say. Principal food plant: grapevine.

Treatment: Burn rubbish in fall or spring, early spray with kerosene emulsion.

Chief accessible article: **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 400-2.

31 **Currant stem-borer,** Sesia tipuliformis Linn. Principal food plant: currant.

Treatment: Cut and burn infested stems.

32 **Red-breasted currant borer,** Tenthredo rufopectus Nort. Principal food plant: currant.

Treatment: Cut and burn wilting tips.

Chief accessible article: **Lintner, J. A.,** state ent. 13th rep't, '97. p. 335-37.

33 **Currant sawfly,** Pteronus ribesii Scop. Principal food plant: currant.

Treatment: Spray foliage with hellebore or an arsenical poison.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 12th rep't, '67. p. 909-32; **Lintner, J. A.,** state ent. 2d rep't, '85. p. 217-21.

34 **Currant spanworm,** Diastictis ribearia Fitch. Principal food plant: currant.

Treatment: Spray foliage with an arsenical poison.

Chief accessible notices: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 310-11; **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 13-14.

35 **Tarnished plant bug,** Lygus pratensis Linn. Principal food plant: peachtree.

Treatment: hand picking, dusting with ashes, clean culture.

Chief accessible article: **Lintner, J. A.,** state ent. 13th rep't, '97. p. 351-57.

36 **4 lined leaf bug,** Poecilocapsus lineatus Fabr. Principal food plant: currant.

Treatment: Spray young with kerosene emulsion, cut and burn egg-bearing twigs.

Chief accessible articles: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 271–81; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 58. '93. p. 207–39.

37 **Gouty gall beetle,** Agrilus ruficollis Fabr. Principal food plant: raspberry.

Treatment: Cut and burn infested canes in early spring.

Chief accessible articles: **Lintner, J. A.,** state ent. 6th rep't, '90. p. 123–25; ——— 10th rep't, '94. p. 406–7.

38 White flower cricket, *Oecanthus niveus* DeG. Principal injury to raspberry bushes.

Treatment: Cut and burn infested canes in early spring. Clean culture.

39 Fuller's rose beetle, *Aramigus fulleri* Horn. Principal food plant: rosebush.

Treatment: hand picking.

Chief accessible article: Lintner, J. A., state ent. 2d rep't, '85. p. 142–44.

40 *Thyreus abbotii* Swains. Principal food plants: grapevine, Virginia creeper.

Treatment: hand picking.

Chief accessible article: Cooley, R. A. Mass agric. exp. sta. Bul. 36. '96. p. 11–12.

41 Cranberry worm, *Rhopobota vacciniana* Pack. Principal food plant: cranberry.

Treatment: Flow bogs after eggs hatch, spray vines with arsenical poisons.

Chief accessible articles: Smith, J. B. N. J. agric. exp. sta. Special bul. K. '90. p. 10–15; Fernald, C. H. Mass. (Hatch) exp. sta. Bul. 19. '92. p. 135–37; —— Mass. state board agric. Rep't, '97. p. 145–48.

GARDEN INSECTS (42–68)

For general works, *see* last two publications cited under Fruit tree insects, p. 833.

42 Wheat wireworm, *Agriotes mancus* Say. This insect and its allies may injure a number of garden crops.

Treatment: Fall plowing; use poisoned baits for beetles.

Chief accessible articles: Comstock, J. H., and Slingerland, M. V. Cornell agric. exp. sta. Bul. 33. '91. p. 251–58; —— —— Bul. 107. '96. p. 51–52.

43 Cabbage butterfly, *Pieris rapae* Linn. Principal food plant: cabbage.

Treatment: Spray young plants with arsenical poisons, use hellebore or pyrethrum on older ones.

Chief accessible notice: Felt, E. P. N. Y. state mus. Bul. 37. '00. p. 29-30.

44 **Zebra caterpillar,** Mamestra picta Harr. Principal food plant: cabbage.

Treatment: Spray young plants with arsenical poisons, use pyrethrum or hellebore on older ones.

Chief accessible articles: **Lintner, J. A.**, state ent. 5th rep't, '89. p. 206-10; **Felt, E. P.**, state ent. 14th rep't, '98. p. 201-7.

45 Microplitis mamestrae, Weed, a parasite of the preceding.

46 **Variegated cutworm,** Peridroma saucia Hübn. Principal food plants: a number of garden crops.

Treatment: poisoned baits.

Chief accessible article: **Lintner, J. A.**, state ent. 5th rep't, '89. p. 200-6.

47 **Colorado potato beetle,** Doryphora 10-lineata Say. Principal food plant: potato.

Treatment: Spray with arsenical poisons, hand picking.

48 Lebia grandis Hentz. This species preys on the preceding.

49 **Spined soldier bug,** Podisus spinosus Dall. Another predaceous enemy of 47.

50 **Margined blister beetle,** Epicauta cinerea Forst. Principal food plant: frequently injures potatoes.

Treatment: Dust vines with ashes, plaster, etc., spray with arsenical poisons only when necessary, as the young are beneficial.

Chief accessible article: **Lintner, J. A.**, state ent. 6th rep't, '90. p. 134-35.

51 **Striped blister beetle,** Epicauta vittata Fabr. Principal food plant: frequently injures potatoes.

Treatment: Same as preceding.

Chief accessible article: **Lintner, J. A.**, state ent. 6th rep't, '90. p. 132-34.

52 **Stalk-borer,** Hydroecia nitela Guen. Principal food plants: tomato, potato and other thick stalked plants.

Treatment: Destroy caterpillars in wilting stalks.

Chief accessible article: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 110-16.

53 Tomato worm, Phlegethontius celeus Hübn. Principal food plant: tomato.

Treatment: Spray with arsenical poisons before fruit appears, hand picking.

Chief accessible article: **Howard, L. O.** U. S. dep't agric. Yearbook. '98. p. 128-32.

54 **Striped cucumber beetle,** Diabrotica vittata Fabr. Principal food plant: cucumber vines.

Treatment: Spray vines with poisoned bordeaux mixture, dust vines with ashes, plaster, etc.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 31, 2d s. '98. p. 1–7; **Sirrine, F. A.** N. Y. agric. exp. sta. Bul. 158. '99. p. 1-32.

55 **Squash vine borer,** Melittia satyriniformis Hübn. Principal food plant: squash vines.

Treatment: Plant early squashes as a trap crop, cut out and destroy borers.

Chief accessible article: **Lintner, J. A.,** state ent. 2d rep't, '85. p. 57–68; **Sirrine, F. A.** N. Y. agric. exp. sta. 15th rep't, '96. p. 610-12; **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 38, 2d s. '99. p. 1–6; —— —— Bul. 19, n. s. '99. p. 34–40.

56 **Cucumber flea beetle,** Epitrix cucumeris Harris. Principal food plants: cucumbers, potatoes, tomatoes.

Treatment: Spray plants with poisoned bordeaux mixture, dust with ashes, plaster, etc.

Chief accessible article: **Stewart, F. C.** N. Y. agric. exp. sta. Bul. 113. '96. p. 311-17.

57 **Red-headed flea beetle,** Systena frontalis Fabr. Principal injury recorded was to sugar beets.

Treatment: Spray plants with arsenical poisons, the poisoned bordeaux mixture being specially effective.

Chief accessible notice: **Felt, E. P.,** state ent. 15th rep't, '00. p. 538.

58 **Common asparagus beetle,** Crioceris asparagi Linn. Principal food plant: asparagus.

Treatment: spray all except cutting beds with an arsenical poison, dust plants with plaster, ashes, etc.

Chief accessible articles: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 239–46; —— 11th rep't, 95. p. 177–81; **Chittenden, F. H.** U. S. dep't agric. Yearbook. '96. p. 342-49; **Felt, E. P.**, state ent. 15th rep't, '00. p. 540-41.

59 12 spotted asparagus beetle, Crioceris 12-punctata Linn. Principal food plant: asparagus.

Treatment: same as for the preceding species.

Chief accessible articles: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 248-52; **Chittenden, F. H.** U. S. dep't agric. Yearbook. '96. p. 349-52; **Felt, E. P.**, state ent. 15th rep't, '00. p. 540-41.

60 Squash bug, Anasa tristis DeG. Principal food plant: squash vine.

Treatment: Trap under chips and destroy the bugs, collect and destroy the eggs.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 19, n. s. '99. p. 20-28; —— —— Circ. 39, 2d s. '99. p. 1-5.

61 Onion thrips, Thrips tabaci Lind. Principal food plants: onion, lettuce.

Treatment: Spray affected plants with kerosene emulsion or whale oil soap solution.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 241-47.

62 Rhubarb curculio, Lixus concavus Say. Principal food plant: rhubarb.

Treatment: hand picking.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 23, n. s. '00. p. 61-69.

63 Chrysanthemum fly, Phytomyza chrysanthemi Kow. Principal food plant: chrysanthemum.

Treatment: Destroy infested leaves.

Chief accessible articles: **Lintner, J. A.**, state ent. 4th rep't, '88. p. 73-80; —— 7th rep't, '91. p. 242-46.

64 Mushroom phora, Phora agarici Lintn. Principal food plant: mushrooms.

Treatment: Kill flies with dry pyrethrum.

Chief accessible article: **Lintner, J. A.**, state ent. 10th rep't, '94. p. 399-405.

65 **Manure fly**, *Sciara coprophila* Lintn. Principal food: decaying vegetable matter, rarely injurious.

Treatment: Spray soil with kerosene emulsion and follow with a sprinkling of water.

Chief accessible articles: **Lintner, J. A.**, state ent. 10th rep't, '94. p. 391-97.

66 **Wild parsnip worm**, *Depressaria heracliana* DeG. Principal food plant: wild parsnip, and the species therefore can hardly be considered injurious.

67 **Genista caterpillar**, *Mecyna reversalis* Guen. Principal food plant: Genista and Cytisus.

Treatment: Spray infested plants with hellebore or an arsenical poison.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 142-45.

68 **Milkweed butterfly**, *Anosia plexippus* Linn. Principal food plant: common milkweed. This is a common but not an injurious species.

GRASS AND GRAIN INSECTS (69-83)

For general works, *see* last two publications cited under Fruit tree insects, p. 833.

69 **May beetle**, *Lachnosterna fusca* Frohl. Principal food plant: grass roots.

Treatment: Spray infested areas heavily with kerosene emulsion just before a rain or follow spraying with a liberal watering.

Chief accessible article: **Lintner, J. A.**, state ent. 9th rep't, '92. p. 353-57.

70 **Green June beetle**, *Allorhina nitida* Linn. Principal food plant: decomposing vegetable matter and possibly grass roots to some extent.

Treatment: same as for the preceding, also poisoned bran mash.

Chief accessible article: **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 10, n. s. '98. p. 20-26.

71 Punctured clover leaf weevil, Phytonomus punctatus Fabr. Principal food plant: clover.

Treatment: Plow under badly infested fields.

Chief accessible articles: **Lintner, J. A.**, state ent. 1st rep't, '82 p. 247-53; —— 5th rep't, '89. p. 272-73; —— 7th rep't, '91. p. 315-16.

72 Phytonomus nigrirostris Fabr. Principal food plant: clover; it is not a species of much economic importance.

73 Army worm, Leucania unipuncta Haw. Principal food plants: grass and grains.

Treatment: clean culture, debarring from infested fields, poisoned bran mash.

Chief accessible articles: **Lintner, J. A.**, state ent. 11th rep't, '96. p. 190-214; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 133. '97. p. 233-58; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 104., '96. p. 122-29; —— 15th rep't, '96. p. 583-605.

74 Clover hay caterpillar, Pyralis costalis Fabr. Principal food plant: clover.

Treatment: Keep hay clean and dry, salt lower layers, do not allow old hay to remain over from year to year.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 145-51.

75 Hessian fly, Cecidomyia destructor Say. Chief food plant: wheat.

Treatment: Late planting in connection with early sown decoy strips to be plowed under in late fall; grow resistant varieties, cut straw high in infested districts and burn stubble.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 7th rep't, '62. p. 133-44; **Marlatt, C. L.** U. S. dep't agric. div. ent. Circ. 14, 2d s. '95. p. 1-4; **Osborn, Herbert.** U. S. dep't agric. div. ent. Bul. 16, n. s. '98. p. 1-57.

76 Jointworm, Isosoma hordei Harr. Principal food plant: barley.

Treatment: Burn infested straw.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 7th rep't, '62. p. 155-59; **Lintner, J. A.**, state ent. 4th rep't, '88. p. 27-35.

77 **Isosoma grande** Riley. Principal food plant: wheat.

Treatment: same as preceding.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. Rep't, '84. p. 357-58; **Webster, F. M.** U. S. dep't agric. Rep't, '84. p. 383-87; ——— ———, Rep't, '85. p. 311-15; **Riley, C. V.** U. S. dep't agric. Rep't, '86. p. 542-46.

78 **Chinch bug,** Blissus leucopterus Say. Principal food plants: grasses, small grains, corn.

Treatment: Burn grass, etc. sheltering hibernating bugs, sow decoy plots, plow badly infested areas or spray with kerosene emulsion, protect cultivated crops by barriers.

Chief accessible articles: **Lintner, J. A.,** state ent. 2d rep't, '85. p. 148-64; **Webster, F. M.** U. S. dep't agric. div. ent. Bul. 15, n. s. '98. p. 1-82.

79 **Red-legged locust,** Melanoplus femur-rubrum DeG. Principal food plants: grasses and grains.

Treatment: Plow young hoppers under, collect with hopper-dozer; poisoned bran mash.

Chief accessible article: **Lintner, J. A.,** state ent. 10th rep't, '94. p. 439-45.

80 Melanoplus femoratus Burm. Same as 79.

81 **Pellucid locust,** Camnula pellucida Scudd. Same as 79.

82 **Carolina locust,** Dissosteira carolina Linn. Same as 79.

83 Circotettix verruculatus Scudd. Same as 79.

HOUSEHOLD INSECTS (84-99)

84 **Little red ant,** Monomorium pharaonis Linn. Principal food: sweets, lard, etc.

Treatment: Destroy nests with carbon bisulfid, kerosene emulsion or boiling water, trap with lard or sponge dipped in sweetened water and destroy.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 95-99; ——— ——— Circ. 34, 2d s. '98. p. 1-4; **Lintner, J. A.,** state ent. 11th rep't, '95. p. 109-14; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:298-99.

85 **Large black ant**, Camponotus pennsylvanica Cress. Bores in wood and is occasionally found in houses.

Treatment: same as for 84, so far as practicable.

86 **House fly**, Musca domestica Linn. Principal food: a very general feeder.

Treatment: keep premises clean and prevent the flies from getting at manure. Exclude with screens.

Chief accessible articles: **Howard, L. O.**, and **Marlatt, C. L.** U. S. dep't. agric. div. ent. Bul. 4, n. s. '96 p. 43-47; **Howard, L. O.** U. S. dep't agric. div. ent. Circ. 35, 2d s. '98. p. 1-8; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:295-96.

87 **Cheese skipper**, Piophila casei Linn. Principal food: cheese, ham.

Treatment: Exclude flies, keep affected products in darkness, destroy eggs every few days.

Chief accessible articles: **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 102-4; **Lintner, J. A.**, state ent. 12th rep't, '96. p. 229-34; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:300-1.

88 **Larder beetle**, Dermestes lardàrius Linn. Principal food: bacon, dried meat, skins, etc.

Treatment: Keep the beetles away by using screens or tight receptacles, clean up frequently, and give the pest little opportunity to breed.

Chief accessible articles: **Lintner, J. A.**, state ent. 6th rep't, '90. p. 119-23; **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 107-9; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 300.

89 **Croton bug**, Phyllodromia germanica Fabr. Principal food: a very general feeder.

Treatment: Cleanliness and the use of a roach poison, such as Hooper's fatal food; fumigate with sulfur, entice the insects to enter vessels partly filled with stale beer, from which no escape is provided.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 90-95; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 229.

90 **Cockroach,** Periplaneta orientalis Linn. Principal food: a very general feeder.

Treatment: same as for 89.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't. agric. div. ent. Bul. 4, n. s. '96. p. 90-95; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 299.

91 **Black carpet beetle,** Attagenus piceus Oliv. Principal food: woolens, horn, dried animal matter.

Treatment: Use rugs or matting in place of carpet whenever possible. Infested carpets should be taken up and sprayed with benzin, and the cracks in the floor should be filled with plaster before relaying. Clean garments and furs thoroughly and store during the summer in tight boxes. Fumigate infested apartments with sulfur.

Chief accessible articles: **Lintner, J. A.,** state ent. 2d rep't, '85. p. 46-48; —— 9th rep't, '92. p. 299-306; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 61-63; **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 8, n. s. '97. p. 15-19; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 297-98.

92 **Buffalo carpet beetle,** Anthrenus scrophulariae Linn. Principal food: woolens, dried animal matter.

Treatment: same as for 91.

Chief accessible articles: **Lintner, J. A.,** state ent. 9th rep't, '92. p. 299-306; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 58-60; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 297-98.

93 **Two spotted ladybug,** Adalia bipunctata Linn. Food: Preys on other insects and is therefore beneficial, though it is frequently mistaken for a carpet beetle.

Treatment: Always protect the beetles.

Chief accessible articles: **Lintner, J. A.,** state ent. 9th rep't, '92. p. 300; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 297.

94 **Museum pest,** Anthrenus verbasci Linn. Principal food: dried animal matter.

Treatment: Exclude from collections by using tight boxes, and supplement by frequent examinations, fumigate infested boxes with carbon bisulfid.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 8, n. s. '97. p. 22-23.

95 **Clothes moth,** Tineola biselliella Hum. Principal food: woolens.

Treatment: same as for 91.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric div. ent. Circ. 36, 2d s. '98. p. 1-8; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 63-69; **Felt, E. P.** N. Y. state agric soc. Trans. '99. 59: 297-98.

96 **Silver fish,** Thermobia furnorum Rov. Principal food: farinaceous matter.

Treatment: Keep things dry and do not allow them to remain undisturbed for long periods, dust haunts with pyrethrum powder.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 76-78; **Felt, E. P.,** state ent. 14th rep't, '98. p. 216-18; —— N. Y. state agric. soc. Trans. '99. 59: 301.

97 **Bedbug,** Acanthia lectularia Linn. Principal food: blood of certain mammalia.

Treatment: Apply benzin, kerosene, other petroleum oil or corrosive sublimate to crevices in infested beds. Fumigation with sulfur is valuable wherever possible.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 32-38; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 299-300.

98 **Masked bedbug hunter: kissing bug,** Opsicoetus personatus Linn. Principal food: other insects; only occasionally does it attack man.

Treatment: Exclude from houses by the use of screens.

Chief accessible articles: **Howard, L. O.** Popular science monthly, Nov. '99; —— U. S. dep't agric. div. ent. Bul. 22. '00. p. 24-25.

99 **Squash bug,** Anasa tristis DeG. Resembles 98 somewhat, but on comparison a marked difference will be seen.

INSECTS AFFECTING STORED FOOD PRODUCTS (100-8)

100 **Rice weevil**, Calandra oryzae Linn. Principal food: rice or its preparations.

Treatment: Fumigate with carbon bisulfid.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 280-81.

101 Pteromalus calandrae How., a parasite of 100.

102 **Grain moth**, Sitotroga cerealella Oliv. Principal food: corn, wheat.

Treatment: Harvest and thresh grain early, fumigate infested grain with carbon bisulfid.

Chief accessible articles: **Lintner, J. A.**, state ent. 2d rep't, '85. p. 102-10; ——— 10th rep't, '94. p. 377-86; **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 281-83.

103 **Corn Silvanus**, Silvanus surinamensis Linn. Principal food: cereal grains.

Treatment: Fumigate infested materials with carbon bisulfid.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 287.

104 **Meal worm**, Tenebrio molitor Linn. Principal food: corn and rye meal.

Treatment: Fumigate infested meal with carbon bisulfid.

Chief accessible articles: **Lintner, J. A.**, state ent. 8th rep't, '91. p. 176-77; **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 116-17.

105 **Bean weevil**, Bruchus obtectus Say. Principal food: beans.

Treatment: Fumigate infested seeds with carbon bisulfid.

Chief accessible article: **Lintner, J. A.**, state ent. 7th rep't, '91. p. 255-79.

106 **Pea weevil**, Bruchus pisorum Linn. Principal food: pea.

Treatment: Early planting; fumigate infested peas with carbon bisulfid.

Chief accessible article: **Riley, C. V., and Howard, L. O.** Insect life. '91. 4: 297-99.

107 **Confused flour beetle,** Tribolium confusum Duv. Principal food: Farinaceous preparations.

Treatment: Fumigate infested preparations with carbon bisulfid.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 288-89; —— —— div. ent. Bul. 4. '96. p. 113-15.

108 **Cigarette beetle,** Lasioderma testaceum Duft. Principal food: tobacco preparations.

Treatment: Fumigate infested substances with carbon bisulfid, exclude the insects by using tight packages.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 4. n. s. '96. p. 126-27.

BENEFICIAL INSECTS (109-63)

Pollen-carriers

These insects perform a most important function, because many fruit trees depend very largely on insects for the carrying of pollen from flower to flower.

109 **Honey bee,** Apis mellifica Linn. This insect is exceedingly valuable as a pollenizer of plants as well as a producer of honey.

Bumblebees, Bombus

This genus is represented by a number of species, all valuable as pollen-carriers.

110 Bombus fervidus Fabr.
111 B. pennsylvanicus DeG.
112 B. terricola Kirby
113 B. ternarius Say
114 B. vagans Smith
115 B. virginicus Oliv.
116 Melissodes obliqua Say
117 M. perplexa Cress.

Leaf-cutter bees, Megachile

The popular name comes from the peculiar habit certain species, at least, have of cutting bits out of leaves to use in nest building.

118 Megachile montivaga Cress.
119 M. latimanus Say
120 Andrena crataegi Rob.
121 A. fimbriata Smith
122 Agapostemon radiatus Say
123 Halictus parallelus Say
124 Wasp, Polistes pallipes St Farg.
125 Vespa arenaria Fabr.
126 Yellow jacket, Vespa diabolica Sauss.
127 White-faced hornet, Vespa maculata Linn.

Flower flies; syrphus flies, Syrphidae

128 Spilomyia fusca Loew
129 Helophilus latifrons Loew
130 H. similis Macq.
131 Eristalis flavipes Walk.
132 E. tenax Linn.
132a Tropidopria conica Fabr., a parasite of the above.
133 Eristalis transversus Wied.
134 Volucella evecta Walk.

Parasites

A number of serious insect pests are held in check by parasitic enemies. These beneficial species should be protected, and in fighting insects the destruction of parasites should be avoided whenever possible.

135 Pteromalus vanessae How.
136 Pimpla conquisitor Say
137 Ophion purgatum Say
138 Ichneumon flavicornis Cr.
139 Red-tailed tachina fly, Winthemia 4-pustulata Fabr.

Predaceous insects

Some predaceous insects are most efficient aids in controlling insect depredations. The syrphid flies and ladybugs are examples of well known enemies of plant lice.

140 Potter wasp, Eumenes fraternus Say

141 Digger wasp, Bembex fasciata Fabr.

142 Sphaerophoria cylindrica Say

143 Syrphus ribesii Linn.

144 Margined soldier beetle, Chauliognathus marginatus Fabr.

145 Pennsylvania soldier beetle, Chauliognathus pennsylvanicus DeG.

Ladybugs, Coccinellidae

Plant lice or aphids find some of their most serious enemies in this group.

146 Brachyacantha ursina Fabr.

147 Twice-stabbed ladybug, Chilocorus bivulnerus Muls.

148 15 spotted ladybug, Anatis ocellata Linn.

149 Two spotted ladybug, Adalia bipunctata Linn.

150 Coccinella sanguinea Linn.

151 Transverse ladybug, Coccinella transversalis Muls.

152 Nine spotted ladybug, Coccinella 9-notata Herbst.

153 Three banded ladybug, Coccinella trifasciata Linn.

154 Parenthetical ladybug, Hippodamia parenthesis Say

155 Convergent ladybug, Hippodamia convergens Guer.

156 Spotted ladybug, Megilla maculata DeG.

157 Spined soldier bug, Podisus spinosus Dall.

158 Lace-winged fly, Chrysopa species.

Silkworms

The mulberry silkworm is the insect which produces all the raw material from which silks are manufactured. Several related species are also represented in the collection.

159 **Mulberry silkworm,** Bombyx mori Linn.

160 **Cynthia moth,** Samia cynthia Dru.

161 **Polyphemus moth: American silkworm,** Telea polyphemus Cram.

162 **Japanese silkworm,** Antheraea yamimai Guer.

163 **Chinese silkworm,** Antheraea pernyi Guer.

SCALE INSECTS, Coccidae (164-202)

A natural group of great economic importance.

Chief articles on the group

Comstock, J. H. U. S. dep't agric. Rep't, '80. p. 276-349; Cornell univ. dep't ent. 2d rep't, '83. p. 45-147.

Cockerell, T. D. A. Check list of the Coccidae. Ill. state lab. nat. hist. Bul. '96, v. 4, art. 11, p. 318-39; supplement, Ill. state lab. nat. hist. Bul. '99, v. 5, art. 7, p. 389-98.

164 **Cottony cushion scale insect,** Icerya purchasi Mask. This species is of interest on account of its threatening the destruction of the citrus fruit industry of California about 1880. Principal food plants: citrus trees.

Treatment: Importation of natural enemies, fumigation with hydrocyanic acid gas.

Chief articles: Riley, C. V. U. S. dep't agric. Rep't, '86. p. 466-91.

165 **Elm tree bark louse,** Gossyparia ulmi Geoff. Principal food plant: European elms.

Treatment: Spray with kerosene emulsion or a whale oil soap solution in early spring.

Chief accessible articles: Lintner, J. A., state ent. 12th rep't, '96. p. 292-97; Felt, E. P. N. Y. state mus. Bul. 20. '98. p. 16-18; —— —— Bul. 27. '99. p. 46; —— Fisheries, game and forest com. 5th rep't, '99. p. 375-79.

166 **Oak kermes,** Kermes galliformis Riley. Principal food plant: oaks; rarely injurious.

167 **Golden oak scale insect**, Asterolecanium variolosum Ratz. Principal food plant: oak.

Treatment: Spray with kerosene emulsion in early summer.

Chief accessible articles: **Lowe, V. H.** N. Y. agric. exp. sta. Rep't, '95. p. 550-51.

168 **Barnacle scale insect**, Ceroplastes cirripediformis Comst. A southern species which occurs on orange and quince.

169 **Lecanium armeniacum** Craw. A species recently introduced into New York state.

Principal food plants: grape, currant.

Chief accessible notice: **Felt, E. P.**, state ent. 14th rep't, '98. p. 240.

170 **Cherry lecanium**, Lecanium cerasifex Fitch. Occurs rather commonly on maple, oak, cherry and appletrees.

Treatment: Spray infested trees in winter or in early spring with kerosene emulsion (1-4).

171 Lecanium fitchii Sign. Infests raspberry and blackberry bushes.

172 **Common greenhouse lecanium**, Lecanium hesperidum Linn. A bad pest on many house and greenhouse plants.

Treatment: Spray or wash plants with kerosene emulsion or a soap solution.

173 **Black scale insect**, Lecanium oleae Bern. A serious pest on many plants in California.

174 **New York plum scale insect**, Lecanium prunastri Fonsc. Principal food plant: plum.

Treatment: Spray infested trees with kerosene emulsion (1-4) just after the leaves fall.

Chief accessible articles: **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 83. '94. p. 681-99; —— —— Bul. 108. '96. p. 82-86; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 583-86.

175 **Tuliptree scale insect**, Lecanium tulipiferae Cook. Principal food plant: tuliptree.

Treatment: Spray infested trees with kerosene emulsion or whale oil soap solution.

Chief accessible article: **Felt, E. P.**, state ent. 14th rep't, '98. (Mus. bul. 23) p. 213-16.

176 **Cottony maple tree scale insect,** Pulvinaria innumerabilis Rathv. Principal food plants: maple, elm, grape.

Treatment: Spray young in July with kerosene emulsion or whale oil soap solution. A powerful stream of cold water or a stiff brush will dislodge many females.

Chief accessible articles: **Lintner, J. A.**, state ent. 6th rep't, '90. p. 141-47; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 29-31; **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 22, n. s. '00. p. 8-16.

177 **Putnam's scale insect,** Aspidiotus ancylus Putn. Principal food plants: maple, elm, currant, fruit trees.

Treatment: rarely injurious.

Chief accessible articles: **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 593; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 326-30.

178 Aspidiotus dictyospermi Morg. A greenhouse species occurring on Areca lutescens.

179 **Cherry scale insect,** Aspidiotus forbesi Johns. Principal food plants: cherry and apple trees.

Treatment: Spray infested trees in winter or early spring with a contact insecticide.

Chief accessible article: **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 330-32.

180 **Ivy scale insect,** Aspidiotus hederae Vall. Principal food plants: common on ivy and a number of other greenhouse plants.

Treatment: Spray infested plants with an ivory or whale oil soap solution.

Chief accessible articles: **Lintner, J. A.**, state ent. 11th rep't, '96. p. 203-4; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 333-36.

181 Aspidiotus lataniae Sign. A greenhouse species infesting palms.

182 **European fruit tree scale insect,** Aspidiotus ostreaeformis Curt. Principal food plant: plum.

Treatment: Spray infested trees in winter or early spring with contact insecticides.

Chief accessible article: **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 323-26.

183 **San José scale insect,** Aspidiotus perniciosus Comst. Principal food plants: fruit and many other trees and shrubs.

Treatment: Spray infested trees in winter or early spring with whale oil soap or a mechanical emulsion of crude petroleum.

Chief accessible articles: **Lintner, J. A.,** state ent. 11th rep't, '96. p. 200-33; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 1-80; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 571-602; **Howard, L. O.,** U. S. dep't agric. div. ent. Bul. 12, n.s. '98. p. 1, 1-32; **Felt, E. P.,** state ent. 16th rep't, '00. p. 967-88; —— N. Y. state mus. Bul. 46. '01. p. 304-23, 336-42.

184 **Gloomy scale insect,** Aspidiotus tenebricosus Comst. A southern species infesting red maple.

185 **Elm Aspidiotus,** Aspidiotus ulmi Johns. Principal food plant: elm, rarely injurious.

186 **Grapevine Aspidiotus,** Aspidiotus uvae Comst. A southern species infesting grapvines.

187 **Red scale insect of Florida,** Chrysomphalus aonidum Linn. Principal food plants: on palms and other greenhouse plants.

Treatment: Wash or spray infested plants with whale oil or other soap solution.

188 Xerophilaspis prosopidis Ckll. A southern species occurring on Prosopis velutina.

189 **Cactus scale insect,** Diaspis calyptroides Costa. Found on cactuses in greenhouses.

190 **Juniper scale insect,** Diaspis carueli Targ. Found occasionally on juniper in New York state.

191 **Peach scale insect,** Diaspis pentagona Targ. A dangerous subtropic species which has become established in localities in the southern United States.

192 Aulacaspis boisduvalii Sign. Found on a greenhouse orchid.

193 Aulacaspis elegans Leon. A greenhouse species infesting Cycas revoluta, frequently called sago palm.

194 **Rose scale insect,** Aulacaspis rosae Sandb. Principal food plants: rose, blackberry, raspberry bushes.

Treatment: Spray infested plants with kerosene emulsion or whale oil soap solution.

195 **Orange chaff scale insect,** Parlatoria pergandii Comst. Chief food plants: orange, tangerine.

It is limited to greenhouses in the north.

196 **Orange scale insect,** Mytilaspis citricola Pack. Occurs on oranges in the south and may infest trees kept in greenhouses in the north.

197 **Appletree bark louse,** Mytilaspis pomorum Bouché. Principal food plants: apple and many other trees.

Treatment: Spray young about June 1 with kerosene emulsion or whale oil soap solution.

Chief accessible articles: **Lintner, J. A.,** state ent. 4th rep't, '88. p. 114-20; **Howard, L. O.** U. S. dep't agric. Yearbook. '94. p. 254-59; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 297-300.

198 **Elm Chionaspis,** Chionaspis americana Johns. Rather common on American elm, rarely very injurious.

199 **Euonymus scale insect,** Chionaspis euonymi Comst. Principal food plant: Euonymus or strawberry tree.

200 **Scurfy bark louse,** Chionaspis furfura Fitch. Principal food plant: apple and other fruit trees.

Treatment: Spray young about June 1 with kerosene emulsion or whale oil soap solution.

Chief accessible articles: **Howard, L. O.** U. S. dep't agric. Yearbook. '94. p. 259-61; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 300-4.

201 **Pine leaf scale insect,** Chionaspis pinifoliae Fitch. Attacks various pines, specially those growing in parks.

Chief accessible notice: **Lintner, J. A.,** state ent. 11th rep't, '96. p. 203.

202 Hemichionaspis aspidistrae Sign. Infests ferns in greenhouses.

FOREST INSECTS (203-51)

General works on the group

Fitch, Asa. Noxious and beneficial insects of New York. 4th rep't, '57. p. 5-67; ——— ——— 5th rep't, '58. p. 1-74.

Packard, A. S. Forest insects. U. S. ent. com. 5th rep't, '90. p. 1-957.

Hopkins, A. D. Catalogue of West Virginia forest and shade tree insects. W. Va. agric. exp. sta. Bul. 32. '93. p. 171-251; ——— Preliminary report on the insect enemies of forests in the northwest. U. S. dep't agric. div. ent. Bul. 21, n. s. '99. p. 1-27.

Woodborers, various species.

203 Xiphydria provancheri Cr. A borer in paper birch, Adirondack region.

204 **Carpenter moth,** Prionoxystus robiniae Peck. A serious enemy of maple and oak trees.

205 **Pitch pine twig Tortrix,** Retinia comstockiana Fern. A twig-borer causing considerable exudations of pitch.

206 **Bronze birch borer,** Agrilus anxius Gory. Principal food plant: white birch, specially injurious in parks.

Treatment: Cut and burn badly infested trees.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 18, n. s. '98. p. 44-51.

207 **Mapletree pruner,** Elaphidion villosum Fabr. Principal food plants: maple, oak.

Treatment: Gather and burn cut limbs in fall or early spring.

Chief accessible articles: **Lintner, J. A.,** state ent. 9th rep't, '92. p. 357-61; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 28-29.

208 **Pine sawyer,** Monohammus confusor Kirby. Attacks pines and spruces.

209 **Pine sawyer,** Monohammus scutellatus Say. Attacks pines.

210 Monohammus titillator Fabr. Attacks pines.

211 **Poplar borer,** Saperda calcarata Say. A serious enemy of poplars in some localities.

212 **Painted hickory borer,** Cyllene pictus Drury. Attacks hickory.

Chief accessible article: **Lintner, J. A.,** state ent. 8th rep't, '91. p. 175-76.

213 **Locust borer,** Cyllene robiniae Forst. A serious enemy of locusttrees.

Chief accessible article: **Hopkins, A. D.** W. Va. agric. exp. sta. Bul. 16. '91. p. 88.

214 **Ribbed Rhagium,** Rhagium lineatum Oliv. Works under dead or dying pine bark.

215 **White pine weevil,** Pissodes strobi Peck. Injures terminal shoots of pine.

216 **Willow snout beetle,** Cryptorhynchus lapathi Linn. An introduced borer which injures poplar and willow.

Bark and wood borers, Scolytids

General works on the group

Hopkins, A. D. Catalogue of West Virginia Scolytidae and their enemies. W. Va. agric. exp. sta. Bul. 31. '93. p. 121-68.

Hubbard, H. G. U. S. dep't agric. div. ent. Bul. 7, n. s. '97. p. 9-30.

217 Monarthrum mali Fitch. Attacks beech, apple.

Chief accessible article: **Fitch, Asa.** Noxious and beneficial insects of New York. 3d rep't, '56. p. 8-9.

218 Gnathotrichus materiarius Fitch. Attacks white and pitch pine.

219 Pityogenes sp. Attacks white pine.

220 Pityophthorus minutissimus Zimm. A bark-miner of red oak.

221 Pityophthorus sp. Working in dead limbs of black birch.

222 Xyloterus politus Say. Attacks beech and soft maple.

223 X. bivittatus Kirby. Attacks balsam stumps.

224 Cryphalus striatus Mann. Attacks balsam, spruce and hemlock.

225 Dryocoetes eichhoffi Hopk. Taken under bark of yellow birch stump.

226 Dryocoetes sp. Working in bark of spruce logs.

227 Xylocleptes sp. Boring in partly decayed twigs of sugar maple.

228 Tomicus calligraphus Germ. Abundant in thicker bark of dying white and pitch pines.

229 T. *cacographus* Lec. Works in the thinner bark of white and pitch pines.

230 T. *pini* Say. Sometimes abundant in bark of young white pines.

231 T. *balsameus* Lec. A serious enemy of balsam trees.

232 T. *caelatus* Eich. Works in thinner bark of white and pitch pines.

233 **Spruce bark beetle,** *Polygraphus rufipennis* Kirby. A serious enemy of the spruce and occurs occasionally in balsam trees.

234 *Phlaeosinus dentatus* Say. Attacks recently cut or dying arbor vitae.

235 **Boring Dendroctonus,** *Dendroctonus terebrans* Oliv. Attacks pitch pines.

Leaf feeders, etc.

236 **Pine sawfly,** *Lophyrus lecontei* Fitch. Strips the needles from white pines.

237 **Poplar sawfly,** *Trichiocampus viminalis* Fall. Attacks poplar.

Chief accessible article: **Lintner, J. A.,** state ent. 4th rep't, '88. p. 44-46.

238 **Cherry leaf beetle,** *Galerucella cavicollis* Lec. Feeds on wild cherry in Adirondacks, occasionally it attacks cultivated trees.

Treatment: Spray the foliage with an arsenical poison.

Chief accessible article: **Lintner, J. A.,** state ent. 11th rep't, '95. p. 197-98.

239 **Locust leaf-miner,** *Odontota dorsalis* Thunb. Attacks locust trees.

Chief accessible article: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 264-67.

240 **Forest tent-caterpillar,** *Clisiocampa disstria* Hübn. Chief food plants: maple, elm, apple.

Treatment: Protect birds, collect eggs, spray domesticated trees with an arsenical poison.

Chief accessible articles: **Felt, E. P.**, state ent. 14th rep't, '98. p. 191-201; —— Fisheries, game and forest com. 4th rep't, sep. '98. p. 10-16; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 159. '99. p. 33-60; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 170. '99. p. 557-64; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:275-76; —— state ent. 16th rep't, '01. p. 994-98.

241 Pimpla conquisitor Say. A parasite of 240.

242 Tachina mella Walk. A parasite of 240.

243 Theronia fulvescens Cress. A parasite of 240.

244 Pteromalus vanessae How. A parasite of 240.

245 **Fall webworm**, Hyphantria cunea Drury. Principal food plants: white elm, willows and poplars.

Treatment: Spray infested limbs with an arsenical poison.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. div. ent. Bul. 10. '87. p. 33-53; **Howard, L. O.** U. S. dep't agric. Yearbook. '95. p. 375-76; **Felt, E. P.** Fisheries, game and forest com. 5th rep't, '99. p. 363-68.

246 **Orange striped oak worm**, Anisota senatoria Abb. & Sm. Principal food plants: various species of oak.

Chief accessible article: **Lintner, J. A.**, state ent. 5th rep't, '89. p. 192-200.

247 **Hickory tussock moth**, Halisidota caryae Harris. Principal food plants: hickory, walnut, butternut.

248 **Cherrytree tortrix**, Cacoecia cerasivorana Fitch. Principal food plant: cherry, birch.

249 **Birch Bucculatrix**, Bucculatrix canadensisella Chamb. Sometimes very injurious to white birch.

250 **Maple leaf-miner**, Lithocolletis aceriella Clem. Attacks leaves of maples and witch-hazel.

251 **17 year cicada**, Cicada septendecim Linn. Injures twigs of many trees by cutting slits in them for the reception of eggs.

Chief accessible articles: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 272-89; **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 14. '98. p. 148.

SHADE TREE INSECTS (252-67)

252 **Mapletree borer,** Plagionotus speciosus Say. Principal food plant: sugar mapletrees.

Treatment: Dig out the young borers.

Chief accessible articles: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 237-48; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 22-28; —— N. Y. state agric. soc. Trans. '99. 59:277-78.

253 **Leopard moth,** Zeuzera pyrina Fabr. Chief food plants: attacks a large number of trees.

Treatment: Destroy females, dig out young borers, kill larger ones in burrows with carbon bisulfid.

Chief accessible articles: **Lintner, J. A.** state ent. 9th rep't, '93. p. 426-27; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 16-20.

254 **Elm bark-borer,** Saperda tridentata Oliv. Principal food plant: American elm.

Treatment: Cut and burn badly infested trees or limbs.

Chief accessible articles: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 243-48; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 278-79; —— Fisheries, game and forest com. 5th rep't, '99. p. 371-75.

255 **Elm snout beetle,** Magdalis barbita Say. Principal food plant: American elm.

Treatment: Cut and burn badly infested limbs.

Chief accessible notices: **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 22; —— Fisheries, game and forest com. 5th rep't, '99. p. 374.

256 **Pigeon tremex,** Tremex columba Linn. Principal food plants: diseased maples and elms.

Chief accessible notices: **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 18-19; —— Fisheries, game and forest com. 4th rep't, '98. p. 25-26.

257 **Lunate long sting,** Thalessa lunator Fabr. A parasite of 256.

Chief accessible articles: **Lintner, J. A.**, state ent. 4th rep't, '88. p. 35-41; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 25-26.

258 **Elm bark louse,** G o s s y p a r i a u l m i Geoff. Chief food plants: European elms.

Treatment: Brush or wash off the bark lice, spray in July or early spring with kerosene emulsion or whale oil soap.

Chief accessible articles: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 292-98; **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 10-18; —— Fisheries, game and forest com. 5th rep't, '99. p. 375-79.

259 **Elm leaf beetle,** G a l e r u c e l l a l u t e o l a Müll. Principal food plants: European elms.

Treatment: Spray infested trees with arsenical poisons.

Chief accessible articles: **Lintner, J. A.**, state ent. 5th rep't, '89. p. 234-42; —— —— 11th rep't, '95. p. 189-96; **Howard, L. O.** U. S. dep't agric. Yearbook. '95. p. 363-68; **Lintner, J. A.** state ent. 12th rep't, '96. p. 253-64; **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 1-43; —— state ent. 14th rep't, '98. p. 232-35; —— N. Y. state agric. soc. Trans. '99, 59: 279; —— Fisheries, game and forest com. 5th rep't, '99. p. 354-59.

260 **Spined soldier bug,** P o d i s u s s p i n o s u s Dall. An enemy of 259.

261 **Fungus disease,** S p o r o t r i c h u m e n t o m o p h i l u m Peck. An enemy of 259.

262 **White marked tussock moth,** N o t o l o p h u s l e u c o s t i g m a Abb. & Sm. Principal food plants: horsechestnut, linden, maple and elm trees.

Treatment: Collect and destroy egg masses, spray infested trees with arsenical poisons.

Chief accessible articles: **Lintner, J. A.**, state ent. 2d rep't, '85. p. 68-89; —— 11th rep't, '95. p. 124-26; **Howard, L. O.** U. S. dep't. agric. Yearbook. '95. p. 368-75; **Felt, E. P.**, state ent. 14th rep't, '98. p. 163-76; —— Fisheries, game and forest com. 4th rep't, sep. '98. p. 4-10.

263 P i m p l a c o n q u i s i t o r Say. A parasite of 262.

264 T a c h i n a m e l l a Walk. A parasite of 262.

265 **Bag worm,** *Thyridopteryx ephemeraeformis* Haw. Principal food plants: arbor vitae, red cedar.

Treatment: Hand picking, spray with arsenical poisons.

Chief accessible articles: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 81-87; **Riley, C. V.** U. S. dep't agric. div. ent. Bul. 10. '87. p. 22-28; **Felt, E. P.** Fisheries, game and forest com. 5th rep't, '99. p. 359-63.

266 **Spiny elm caterpillar,** *Euvanessa antiopa* Linn. Principal food plants: elm, willow, poplar.

Treatment: Spray infested trees with arsenical poisons.

Chief accessible articles: **Weed, C. M.** N. H. agric. exp. sta. Bul. '67. '99. p. 125-41; **Felt, E. P.** Fisheries, game and forest com. 5th rep't, '99. p. 368-71.

267 *Pteromalus fuscipes* Prov. A parasite of 266.

WORK OF GALL INSECTS (268-97)

Galls of sawflies, *Tenthredinidae*

268 **Willow apple gall,** *Pontania pomum* Walsh

4 winged gallflies, *Cynipidae*

269 **Mealy rose gall,** *Rhodites ignota* O. S.

270 **Mossy rose gall,** *Rhodites rosae* Linn.

271 **Large oak apple,** *Amphibolips confluentus* Harr.

272 **Black scrub oak apple,** *Amphibolips ilicifoliae* Bass.

273 **Oak plum gall,** *Amphibolips prunus* Walsh

274 **Gall of wool sower,** *Andricus seminator* Harris

275 **Oak leaf-stalk gall,** *Andricus petiolicola* Bass.

276 **Oak-wool gall,** *Andricus lana* Fitch

277 **Woolly oak gall,** *Andricus operator* O. S.

278 **Fuzzy chestnut leaf gall,** ? *Cynips prinoides* Beutm.

279 **Lobed oak gall,** *Cynips strobilana* O. S.

280 *Cynips decidua* Bass.

281 **Oak fig gall,** *Biorhiza fortcornis* Walsh

282 **Larger empty oak apple,** *Holcaspis inanis* O. S.

283 Bullet gall, Holcaspis globulus Fitch
284 Rough bullet gall, Holcaspis duricola Bass.
285 Oak leaf bullet gall, Dryophanta polita Bass.
286 Oak potato gall, Neuroterus batatus Fitch

2 winged gallflies, Diptera

Gall gnats, Cecidomyiidae

287 Hickory leaf gall, Cecidomyia holotricha O. S.
288 Willow cone gall, Cecidomyia strobiloides O. S.
289 Balsam leaf gall, Cecidomyia balsamicola Lintn.

Trypetid galls

290 Small solidago gall, Trypeta polita Loew
291 Large solidago gall, Trypeta solidaginis Fitch

Psyllid galls, Psyllidae

292 Hackberry leaf gall, Pachypsylla celtidis-mamma Riley

Galls of plant lice, Aphididae

293 Witch-hazel gall, Hormaphis hamamelidis Fitch
294 Cockscomb elm gall, Colopha ulmicola Fitch
295 Poplar leaf stem gall, Pemphigus populi-transversus Riley
296 Phylloxera galls, Phylloxera vitifoliae Fitch
297 Larch aphid gall, Chermes abietis Linn.

BEE AND WASP FAMILY, Hymenoptera (298-384)

Long-tongued bees Apidae

298 Honey bee, Apis mellifica Linn.
299 Bombus virginicus Oliv.
300 B. vagans Smith
301 B. terricola Kirby
302 B. ternarius Say
303 B. fervidus Fabr.
304 Psithyrus elatus Fabr.
305 P. ashtoni Cr.

306 Xylocopa virginica Drury
307 Clisodon terminalis Cr.
308 Melissodes perplexa Cr.
309 M. aurigenia Cr.
310 Ceratina dupla Say
311 Megachile montivaga Cr.
312 M. melanophaea Smith
313 M. latimanus Say
314 Alcidamea producta Cr.
315 Andronicus cylindricus Cr.
316 Osmia lignaria Say
317 Stelis lateralis Cr.

Short-tongued bees Andrenidae

318 Andrena vicina Smith
319 A. nubecula Smith
320 A. forbesii Rob.
321 A. crataegi Rob.
322 Augochlora pura Say
323 Halictus zephyrus Smith
324 H. pilosus Smith
325 H. confusus Smith
326 Sphecodes arvensis Pttn.
327 Prosopis elliptica Kirby
328 P. affinis Smith
329 Colletes inaequalis Say

Social wasps, Vespidae

330 Vespa vulgaris Linn.
331 White-faced hornet, Vespa maculata Linn.
332 Vespa germanica Fabr.
333 Yellow jacket, Vespa diabolica Sauss.
334 Vespa consobrina Sauss.
335 V. arenaria Fabr.
336 Common wasp, Polistes pallipes St Farg.

Solitary wasps, Eumenidae

337 Odynerus unifasciatus Sauss.
338 O. philadelphiae Sauss.

Crabronidae

339 Crabro trifasciatus Say
340 C. 6-maculatus Say
341 C. producticollis Pack.
342 C. interruptus St Farg.

Pemphredonidae

343 Pemphredon concolor Say

Philanthidae

344 Cerceris dentifrons Cr.
345 Philanthus bilunatus Cr.

Nyssonidae

346 Hoplisus phaleratus Say

Bembecidae

347 Monedula ventralis Say
348 M. 4-fasciata Say
349 Microbembex monodonta Say
350 Bembex fasciata Fabr.

Thread-waisted wasps, Sphecidae

351 Sphex ichneumonea Linn.
352 Isodontia philadelphica St Farg.
353 Mud dauber, Chalybion caeruleum Linn.
354 Mud dauber, Pelopoeus cementarius Drury
355 Ammophila gracilis St Farg.
356 A. communis Cr.

Spider wasps, Pompilidae

357 Pompilus marginatus Say
358 P. aethiops Cr.

Scoliidae

359 Myzine 6-cincta Fabr.
360 Tiphia inornata Say

Ants, Formicidae

361 Camponotus herculaneus Linn.

Cuckoo flies, Chrysididae

362 ?Chrysis sp.

Pelecinidae

363 Pelecinus polyturator Drury

Chalcis flies, Chalcididae

364 Dibrachys boucheanus Ratz.
365 Pteromalus vanessae How.
366 P. cuproideus How.
367 Isosoma captivum How.

Braconidae

368 Apanteles congregatus Say

Ichneumon flies, Ichneumonidae

369 Pimpla inquisitor Say
370 **Lunate long sting,** Thalessa lunator Fabr.
371 **Black long sting,** Thalessa atrata Fabr.
372 Opheltes glaucopterus Linn.
373 Exochilum mundum Say
374 Ophion purgatum Say
375 Cryptus nuncius Say
376 Ichneumon laetus Brullé

Ensign flies, Evaniidae

377 Foenus tarsatorius Say

Gallflies, Cynipidae

378 Holcaspis duricola Bass

Horntails, Uroceridae

379 **Pigeon tremex,** Tremex columba Linn.
380 Xiphydria provancheri Cr.
381 **Currant stem girdler,** Janus integer Nort.

Sawflies, Tenthredinidae

382 Tenthredo rufipes Fabr.
383 Allantus basilaris Say
384 **American sawfly,** Cimbex americana Leach

BEETLES, Coleoptera (385-597)

Anthribidae

385 Cratoparis lunatus Fabr.

Bark-borers, Scolytidae

386 Phloeotribus frontalis Oliv.

387 Spruce bark beetle, Polygraphus rufipennis Kirby

388 Fruit tree bark beetle, Scolytus rugulosus Ratz.

389 Tomicus balsameus Lec.

390 T. pini Say

391 T. calligraphus Germ.

392 Xyloterus politus Say

393 Pityogenes *sp.*

394 Pityophthorus minutissimus Zimm.

395 Pityophthorus *sp.*

Bill bugs, Calandridae

396 Grain weevil, Calandra granaria Linn.

Brenthidae

397 Eupsalis minuta Drury

Snout beetles, Curculionidae

398 Mononychus vulpeculus Fabr.

399 Willow snout beetle, Cryptorhynchus lapathi Linn.

400 Plum curculio, Conotrachelus nenuphar Herbst

401 Elm snout beetle, Magdalis armicollis Say

402 Rhubarb curculio, Lixus concavus Say

403 Punctured clover leaf weevil, Phytonomus punctatus Fabr.

404 New York weevil, Ithycerus noveboracensis Forst.

Scarred snout beetles, Otiorhynchidae

405 Aphrastus taeniatus Gyll.

Rhynchitidae

406 Rhynchites bicolor Fabr.

Blister beetles, Meloidae

407 Say's blister beetle, Pomphopoea sayi Lec.

408 Black blister beetle, Epicauta pennsylvanica DeG.

409 Striped blister beetle, Epicauta vittata Fabr.

410 Meloe angusticollis Say

Anthicidae

411 Notoxus anchora Hentz.

Pythidae

412 Pytho americanus Kirby

Melandryidae

413 Penthe obliquata Fabr.

Darkling beetles, Tenebrionidae

414 Forked fungus beetle, Boletotherus bifurcus Fabr.

415 Hoplocephala bicornis Oliv.

416 Meal worm, Tenebrio molitor Linn.

417 Scotobates calcaratus Fabr.

418 Upis ceramboides Linn.

419 Iphthimus opacus Lec.

420 Alobates pennsylvanica DeG.

Weevils, Brüchidae

421 Bean weevil, Bruchus obtectus Say

Leaf beetles, Chrysomelidae

422 Argus beetle, Chelymorpha argus Licht.

423 Clubbed tortoise beetle, Coptocycla clavata Fabr.

424 Spotted tortoise beetle, Coptocycla signifera Herbst

425 Golden tortoise beetle, Coptocycla bicolor Fabr.

426 Disonycha caroliniana Fabr.

427 Elm leaf beetle, Galerucella luteola Müll.

428 Trirhabda canadensis Kirby

429 Striped cucumber beetle, Diabrotica vittata Fabr.

430 Willow leaf beetle, Lina scripta Fabr.
431 Gastroidea polygoni Linn.
432 Chrysomela bigsbyana Kirby
433 C. philadelphica Linn.
434 C. scalaris Lec.
435 C. elegans Oliv.
436 C. similis Rog.
437 Potato beetle, Doryphora 10-lineata Say
438 Three spotted Doryphora, Doryphora clivicollis Kirby
439 Gold gilt beetle, Chrysochus auratus Fabr.
440 Chlamys plicata Fabr.
441 Twelve spotted asparagus beetle, Crioceris 12-punctata Linn.
442 Asparagus beetle, Crioceris asparagi Linn.
443 Three lined Lema, Lema trilineata Oliv.
444 Donacia femoralis Kirby

Long-horned woodborers, Cerambycidae

445 Spotted milkweed beetle, Tetraopes tetraophthalmus Forst.
446 Saperda puncticollis Say
447 S. lateralis Fabr.
448 S. vestita Say
449 Liopus variegatus Hald.
450 Monohammus maculosus Hald.
451 Leptura vittata Germ.
452 L. proxima Say
453 L. vagans Oliv.
454 L. rubrica Say
455 L. canadensis Fabr.
456 L. cordifera Oliv.
457 Typocerus velutinus Oliv.
458 Cloaked knotty horn, Desmocerus palliatus Forst.
459 Euderces picipes Fabr.
460 Clytanthus ruricola Oliv.

461 Neoclytus erythrocephalus Fabr.
462 Xylotrechus undulatus Say
463 X. colonus Fabr.
464 Arhopalus fulminans Fabr.
465 Phymatodes variabilis Fabr.
466 Physocnemum brevilineum Say
467 Criocephalus agrestis Kirby
468 Broad-necked Prionus, Prionus laticollis Drury
469 Straight-bodied Prionid, Orthosoma brunneum Forst.

Spondylidae

470 Parandra brunnea Fabr.

Lamellicorn beetles, Scarabaeidae

471 Trichius affinis Gory
472 Rough flower beetle, Osmoderma scabra Beauv.
473 Hermit flower beetle, Osmoderma eremicola Knoch.
474 Green June beetle, Allorhina nitida Linn.
475 Spotted grapevine beetle, Pelidnota punctata Linn.
476 Light-loving grapevine beetle, Anomala lucicola Fabr.
477 June beetle, Lachnosterna tristis Fabr.
478 Earth-boring dung beetle, Geotrupes egeriei Germ.
479 Dung beetle, Aphodius fimetarius Linn.
480 Tumble bug, Copris anaglypticus Say
481 Tumble bug, Canthon laevis Drury

Stag beetles, Lucanidae

482 Horned passalus, Passalus cornutus Fabr.
483 Antelope beetle, Dorcus parallelus Say
484 Stag beetle, Lucanus dama Thunb.

Checkered beetles, Cleridae

485 Clerus analis Lec.
486 Trichodes nuttalli Kirby

Fireflies, Lampyridae

487 Soldier beetle, *Chauliognathus pennsylvanicus* DeG.
488 *Photuris pennsylvanica* DeG.
489 *Ellychnia corrusca* Linn.
490 *Eros aurora* Herbst
491 *Calopteron reticulatum* Fabr.

Flat-headed woodborers, Buprestidae

492 Bronze birch borer, *Agrilus anxius* Gory
493 Gouty gall beetle, *Agrilus ruficollis* Fabr.
494 *Chrysobothris dentipes* Germ.
495 Banded buprestid, *Buprestis fasciata* Fabr.
496 *Dicerca divaricata* Say
497 *Chalcophora liberta* Germ.
498 *C. virginiensis* Drury

Snapping beetles, Elateridae

499 *Asaphes baridius* Say
500 *Corymbites hieroglyphicus* Say
501 *C. vernalis* Hentz.
502 *Ludius abruptus* Say
503 *Elater nigricollis* Herbst
504 *Alaus myops* Fabr.
505 Owl beetle, *Alaus oculatus* Linn.
506 *Adelocera brevicornis* Lec.

Nitidulidae

507 Banded Ips, *Ips quadriguttatus* Fabr.
508 *Omosita colon* Linn.
509 *Nitidula bipustulata* Linn.

Histeridae

510 *Hister lecontei* Mars.
511 *H. americanus* Payk.
512 *H. furtivus* Say
513 *H. abbreviatus* Fabr.

Dermestids, Dermestidae

514 Anthrenus verbasci Linn.

515 Buffalo carpet beetle, Anthrenus scrophulariae Linn.

516 Black carpet beetle, Attagenus piceus Oliv.

517 Larder beetle, Dermestes lardarius Linn.

518 Dermestes caninus Germ.

519 Pale brown Byturus, Byturus unicolor Say

Cucujids, Cucujidae

520 Brontes dubius Fabr.

521 Cathartus gemellatus Duv.

522 Corn Silvanus, Silvanus surinamensis Linn.

Erotylidae

523 Megalodacne heros Say

Lady bugs, Coccinellidae

524 Northern lady bug, Epilachna borealis Fabr.

525 Brachyacantha ursina Fabr.

526 Twice stabbed lady bug, Chilocorus bivulnerus Muls.

527 15 spotted lady bug, Anatis ocellata Linn.

528 Two spotted lady bug, Adalia bipunctata Linn.

529 Coccinella sanguinea Linn.

530 Nine spotted lady bug, Coccinella 9-notata Herbst

531 Three banded lady bug, Coccinella trifasciata Linn.

532 Parenthetical lady bug, Hippodamia parenthesis Say

533 13 spotted lady bug, Hippodamia 13-punctata Linn.

534 Convergent lady bug, Hippodamia convergens Guer.

535 Spotted lady bug, Megilla maculata DeG.

Rove beetles, Staphylinidae

536 Paederus littorarius Grav.

537 Staphylinus cinnamopterus Grav.

538 S. maculosus Grav.

539 Creophilus villosus Grav.

540 Listotrophus cingulatus Grav.

Carrion beetles, Silphidae

Carrion beetles, Silpha

541 Silpha americana Linn.

542 S. noveboracensis Forst.

543 S. inaequalis Fabr.

544 S. lapponica Herbst

545 S. surinamensis Fabr.

Burying beetles, Necrophorus

546 Necrophorus tomentosus Web.

547 N. marginatus Fabr.

548 N. americanus Oliv.

Scavenger water beetles, Hydrophilidae

549 Sphaeridium scarabaeoides Linn.

550 Hydrobius fuscipes Linn.

551 H. globosus Say

552 Philhydrus cinctus Say

553 Laccobius agilis Rand.

554 Hydrocharis obtusatus Say

555 Hydrophilus glaber Herbst

556 H. mixtus Lec.

557 H. nimbatus Say

558 H. triangularis Say

559 Helophorus lineatus Say

Whirligig beetles, Gyrinidae

560 Dineutes discolor Aubé.

561 Gyrinus picipes Aubé.

562 G. consobrinus Lec.

563 G. ventralis Kirby

564 G. minutus Fabr.

Predaceous diving beetles, Dytiscidae

565 Acilius semisulcatus Aubé.

566 Colymbetes sculptilis Harris

567 Rhantus binotatus Harris
568 Agabus gagates Aubé.
569 A. punctulatus Aubé.
570 Ilybius biguttalus Germ.
571 Deronectes griseostriatus DeG.
572 Laccophilus maculosus Germ.

Haliplidae

573 Haliplus ruficollis DeG.
574 H. fasciatus Aubé.

Ground beetles, Carabidae

575 Anisodactylus baltimorensis Say
576 **Pennsylvanian ground beetle,** Harpalus pennsylvanicus DeG.
577 **Dark ground beetle,** Harpalus caliginosus Fabr.
578 Chlaenius tricolor Dej.
579 C. sériceus Forst.
580 Galerita janus Fabr.
581 Casnonia pennsylvanica Linn.
582 Platynus cupripennis Say
583 Calathus gregarius Say
584 Dicaelus elongatus Bon.
585 Pterostichus lucublandus Say
586 P. stygicus Say
587 Scarites subterraneus Fabr.
588 Elaphrus ruscarius Say
589 **Fiery hunter,** Calosoma calidum Fabr.
590 **Searcher,** Calosoma scrutator Fabr.
591 Carabus vinctus Web.

Tiger beetles, Cicindelidae

592 **Repand tiger beetle,** Cicindela repanda Dej.
593 **Common tiger beetle,** Cicindela vulgaris Say
594 **Noble tiger beetle,** Cicindela generosa Dej.
595 **Purple tiger beetle,** Cicindela purpurea Oliv.
596 **Six spotted tiger beetle,** Cicindela 6-guttata Fabr.
597 Cicindela longilabris Say

FLEAS, Siphonaptera

598 **Dog and cat flea,** Ceratopsyllus serraticeps Gerv.

TWO-WINGED FLIES, Diptera (599-653)

Humpbacked flies, Phoridae

599 **Mushroom Phora,** Phora agarici Lintn.

Phytomyzidae

600 **Chrysanthemum fly,** Phytomyza chrysanthemi Kow.

Grain flies, Oscinidae

601 **Prolific Chlorops,** Chloropisca variceps Loew

Trypetidae

602 Trypeta festiva Loew
603 T. sparsa Wied.
604 T. florescentiae Linn.
605 T. longipennis Wied.

Ortalidae

606 Seoptera colon Harris
607 Rivellia viridulans R. Desv.

Dung flies, Cordyluridae

608 Scatophaga stercoraria Linn.

Anthomyiids, Anthomyiidae

609 **Locust egg anthomyian,** Phorbia fusciceps Zett.

House fly family, Muscidae

610 **House fly,** Musca domestica Linn.
611 **Cluster fly,** Pollenia rudis Fabr.
612 **Horn fly,** Haematobia serrata R. Desv.
613 **Stable fly,** Stomoxys calcitrans Linn.

Flesh flies, Sarcophagidae

614 Sarcophaga sp.

Tachina flies, Tachinidae

615 Tachina mella Walk.
616 Bombyliomyia abrupta Wied.

Syrphus flies, Syrphidae

617 Spilomyia fusca Loew
618 Helophilus similis Macq.
619 Eristalis transversus Wied.
620 E. tenax Linn.
621 E. androclus O. S.
622 E. flavipes Walk.
623 E. bastardi Macq.
624 Sericomyia limbipennis Macq.
625 Rhingia nasica Say
626 Sphaerophoria cylindrica Say
627 Syrphus americanus Wied.
628 S. lapponicus Zett.

Bee flies, Bombyliidae

629 Bombylius fratellus Wied.
630 Argyramoeba simson Fabr.
631 A. analis Say
632 Anthrax sinuosa Wied.
633 A. tegminipennis Say
634 A. fulviana Say
635 A. alternata Say
636 Exoprosopa dorcadion O. S.

Robber flies, Asilidae

637 Diogmites discolor Loew

Snipe flies, Leptidae

638 Leptis punctipennis Say
639 Chrysopila thoracica Fabr.

Horse flies, Tabanidae

640 Tabanus reinwardtii Wied.
641 Mourning horse fly, Tabanus atratus Fabr.
642 Banded horse fly, Therioplectes cinctus Fabr.
643 Chrysops niger Macq.

Soldier flies, Stratiomyiidae

644 Stratiomyia picipes Loew
645 Metoponia fuscitarsis Say

Crane flies, Tipulidae

646 Tipula fuliginosa Say

March flies, Bibionidae

647 Scatopse notata Linn.

648 Bibio albipennis Say

Black flies, Simuliidae

649 Southern Buffalo gnat, Simulium invenustum Walk.

Fungus gnats, Mycetophilidae

650 Manure fly, Sciara coprophila Lintn.

651 Asyndulum montanum Roed.

Gall gnats, Cecidomyiidae

652 Birch seed midge, Cecidomyia betulae Wintz.

653 Hessian fly, Cecidomyia destructor Say

BUTTERFLIES AND MOTHS, Lepidoptera (654-828)

BUTTERFLIES, Rhopalocera (654-722)

Four-footed butterflies, Nymphalidae

654 Milkweed butterfly, Anosia plexippus Linn.

655 Agraulis vanillae Linn.

656 Thyridia psidii Linn.

657 Lycorea pasinuntia Cram.

658 Regal fritillary, Speyria idalia Drury

659 Great spangled fritillary, Argynnis cybele Fabr.

660 Silver spot fritillary, Argynnis aphrodite var. alcestis Edw.

661 Mountain silver spot, Argynnis atlantis Edw.

662 Meadow fritillary, Brenthis bellona Fabr.

663 Pyrrhopyge acastus Cram.

664 P. phidias Linn.

665 Pearl crescent, Phyciodes tharos var. morpheus Edw.

666 Violet tip, Polygonia interrogationis var. umbrosa Lintn.

667 Hop merchant, Polygonia comma var. harrisii Edw.

668 Green comma, Polygonia faunus Edw.
669 Gray comma, Polygonia progne Cram.
670 Compton tortoise, Eugonia j-album Boisd. & Lec.
671 Mourning cloak, Euvanessa antiopa Linn.
672 American tortoise shell, Aglais milberti Godt.
673 Red admiral, Vanessa atalanta Linn.
674 Painted beauty, Vanessa huntera Fabr.
675 Buckeye, Junonia coenia Hübn.
676 Anartia amalthea Linn.
677 Red spotted purple, Basilarchia astyanax Fabr.
678 Banded purple, Basilarchia arthemis Drury
679 Bastard purple, Basilarchia proserpina Edw.
680 Viceroy, Basilarchia archippus Cram.
681 Ageronia feronia Hübn.
682 A. fornax Hübn.
683 Eyed brown, Satyrodes eurydice Linn. & Joh.
684 Little wood satyr, Cissia eurytus Fabr.
685 Dull-eyed grayling, Cercyonis nephele Kirby
686 Blue-eyed grayling, Cercyonis alope Fabr.

Gossamer-winged butterflies, Lycaenidae

687 Hoary elfin, Incisalia irus Godt.
688 Wanderer, Feneseca tarquinius Fabr.
689 American copper, Heodes hypophlaeas Boisd.
690 Pearl studded violet, Rusticus scudderii Edw.
691 Spring azure, Cyaniris pseudargiolus Boisd. & Lec.
692 Tailed blue, Everes comyntas Godt.

Pierids, Pieridae

693 ?Eronia argia Fabr. (Africa)
694 Checkered white, Pontia protodice Boisd. & Lec.
695 Gray-veined white, Pieris oleracea Harris
696 Cabbage butterfly, Pieris rapae Linn.
697 Catopsilia menippe Hübn.
698 ?C. statira Cram.
699 Cloudless sulfur, Callidryas eubule Linn.

700 Zerene cesonia Stoll.
701 Clouded sulfur, Eurymus philodice Godt.
702 Eurymus philodice pallidice Scudd.
703 Little sulfur, Eurema lisa Boisd. & Lec.

Swallowtails, Papilionidae

704 Iphiclides sp.
705 Zebra swallowtail, Iphiclides ajax telamonoides Feld.
706 Tiger swallowtail, Jasoniades glaucus turnus Linn.
707 Black swallowtail, Papilio polyxenes Fabr.
708 ?Papilio dolichaon Cram.
709 P. sarpedon Linn.
710 Green clouded swallowtail, Euphoeades troilus Linn.
711 Blue swallowtail, Laertias philenor Linn.

Common skippers, Hesperiidae

712 Least skipper, Ancyloxipha numitor Fabr.
713 Mormon, Atrytone zabulon Boisd. & Lec.
714 Yellow spot, Polites peckius Kirby
715 Long dash, Thymelicus mystic Edw.
716 Tawny edged skipper, Limochores taumas Fabr.
717 Dun skipper, Euphyes metacomet Harris
718 Dusted skipper, Lerema hianna Scudd.
719 Dreamy dusky wing, Thanaos icelus Lintn.
720 Martial's dusky wing, Thanaos martialis Scudd.
721 Sooty wing, Pholisora catullus Fabr.
722 Silver spotted skipper, Epargyreus tityrus Fabr.

MOTHS, Heterocera (723-828)

Hawk moths, Sphingidae

723 Bumblebee hawk moth, Hemaris diffinis Boisd.
724 Amphion nessus Cram.
725 Deidamia inscripta Harris
726 White lined sphinx, Deilephila lineata Fabr.
727 Grapevine hog caterpillar, Ampelophaga myron Cram.

728 Pen-marked sphinx, Sphinx chersis Hübn.
729 Sphinx eremitis Hübn.
730 Ceratomia amyntor Hübn.

Clear-winged moths, Sesiidae

731 Currant stem-borer, Sesia tipuliformis Linn.

Wood nymph moths, Agaristidae

732 Eight spotted forester, Alypia octomaculata Fabr.

Zygaenidae

733 Lycomorpha pholus Drury
734 Ctenucha virginica Charp.

Footman moths, Lithosiidae

735 Hypoprepia fucosa Hübn.

Tiger moths, Arctiidae

736 Bella moth, Utetheisa bella Linn.
737 Haploa confusa Lyman
738 Tiger moth, Euprepia virgo Linn.
739 Isabella tiger moth, Pyrrharctia isabella Abb. & Sm.
740 Salt marsh caterpillar, Estigmene acraea Drury
741 Harlequin milkweed caterpillar, Cycnia egle Drury
742 Halisidota tessellaris Abb. & Sm.
743 Hickory tussock moth, Halisidota caryae Harris

Tussock moths, Lymantriidae

744 Notolophus antiqua Linn.
745 Gipsy moth, Porthetria dispar Linn.

Flannel moths, Megalopygidae

746 Crinkled flannel moth, Megalopyge crispata Pack.

Bag worm moths, Psychidae

747 Bag worm moth, Thyridopteryx ephemeraeformis Haw.

Prominents, Notodontidae

748 Cerura cinerea Walk.

Giant silk worms, Saturniidae

749 Luna moth, Tropaea luna Linn.

750 Io moth, Automeris io Fabr.

Royal moths, Citheroniidae

751 Regal moth, Citheronia regalis Fabr.

752 Rosy anisota, Anisota rubicunda Fabr.

Lasiocampidae

753 Tent-caterpillar moth, Clisiocampa americana Fabr.

Carpenter moths, Cossidae

754 Carpenter moth, Prionoxystus robiniae Peck

Cymatophoridae

755 Thyatira scripta Gosse.

Owlet moths, Noctuidae

756 Acronycta americana Harris

757 Feltia subgothica Haw.

758 Xylophasia arctica Boisd.

759 Trigonophora periculosa Guen.

760 Leucania pallens Linn.

761 Pyramidal grapevine caterpillar, Amphipyra pyramidoides Guen.

762 Orthosia helva Grt.

763 Cirroedia pampina Guen.

764 Scoliopteryx libatrix Linn.

765 Scopelosoma indirecta Walk.

766 Cucullia asteroides Guen.

767 Cotton worm moth, Aletia argillacea Hübn.

768 Plusia balluca Geyer

769 P. mortuorum Guen.

770 Boll worm moth, Heliothis armiger Hübn.

771 Alaria florida Guen.

772 Melaporphyria immortua Grt.

773 Erastria concinnimacula Guen.

774 Catocala cerogama Guen.

775 C. ultronia Hübn.

776 C. unijuga Walk.
777 C. cara Guen.
778 Parallelia bistriaris Hübn.
779 Panapoda rufimargo var. carneicosta Guen.
780 Zale horrida Hübn.
781 Homoptera lunata Drury
782 H. minerea Guen.

Measuring worms, Geometridae

783 Sabulodes transversata Drury
784 Tetracis crocallata Guen.
785 Metanema inatomaria Guen.
786 Caberodes confusaria Hübn.
787 Ennomos subsignarius Hübn.
788 Azelina peplaria Hübn.
789 Euchlaena effectaria Walk.
790 Xanthotype crocataria Fabr.
791 Plagodis phlogosaria Guen.
792 Synchlora glaucaria Guen.
793 Deilinia erythremaria Guen.
794 Eudeilinia ?herminiata Guen.
795 Orthofidonia semiclarata Walk.
796 Sciagraphia mellistrigata Grt.
797 Caripeta angustiorata Walk.
798 Epelis faxonii Minot
799 Cingilia catenaria Cram.
800 Nepytia semiclusaria Walk.
801 Lycia cognataria Guen.
802 Euchoeca albovittata Guen.
803 Eucymatoge intestinata Guen.
804 Eustroma diversilineatum Hübn.
805 Mesoleuca hersiliata Guen.
806 M. ruficiliata Guen.
807 M. lacustrata Guen.
808 Gypsochroa designata Bork.

Pyraustidae

809 Grape leaf-folder, Desmia funeralis Hübn.
810 Pyrausta theseusalis Walk.
811 Pantographa limata Grt. & Rob.
812 Evergestis straminalis Hübn.
813 Cataclysta ?opulentalis Led.

Phycitidae

814 Acrobasis rubrifasciella Pack.

Close wings, Crambidae

815 Argyria nivalis Drury
816 Wide-striped Crambus, Crambus unistriatellus Pack.
817 Crambus hastiferellus Walk.
818 Unmarked Crambus, Crambus perlellus Scop.
819 Dark spotted Crambus, Crambus mutabilis Clem.

Plume moths, Pterophoridae

820 Platyptilia ochrodactyla Hübn.
821 Grapevine plume moth, Oxyptilus periscelidactylus Fitch

Leaf-rollers, Tortricidae

822 Teras logiana var. viburnana Clem.
823 Oblique banded leaf-roller, Cacoecia rosaceana Harris
824 Ugly nest tortricid, Cacoecia cerasivorana Fitch
825 V-marked tortrix, Cacoecia argyrospila Walk.
826 Cenopis reticulatana Clem.

Grapholithidae

827 Rose leaf tier, Penthina nimbatana Clem.

Tineina

828 Angoumois grain moth, Sitotroga cerealella Oliv.

CADDIS FLIES, Trichoptera (829-37)

829 Platyphylax subfasciata Say

SCORPION FLIES, Mecoptera

830 Panorpa rufescens Ramb.

831 Bittacus strigosus Hagen

DOBSON AND OTHERS, Neuroptera

832 **Ant lion,** Myrmeleon immaculatus DeGeer

833 Polystoechotes punctatus Fabr.

834 **Lace-winged fly,** Chrysopa ?perla

835 Sialis infirma Newm.

836 **Dobson,** Corydalis cornuta Linn.

837 **Comb-horned fish fly,** Chauliodes serraticornis Say

TRUE BUGS, Hemiptera (838-81)

Leaf hoppers, Jassidae

838 **Grapevine leaf hopper,** Typhlocyba comes Say

839 **Red lined leaf hopper,** Diedrocephala coccinea Forst.

Tree hoppers, Membracidae

840 **Woodbine Telamona,** Telamona ampelopsidis Harris

841 **Two spotted Enchenopa,** Enchenopa binotata Say

842 Stictocephala inermis Fabr.

843 **Buffalo tree hopper,** Ceresa bubalus Fabr.

Spittle insects, Cercopidae

844 Lepyronia 4-angularis Say

Cicadas, Cicadidae

845 **Dog day cicada,** Cicada tibicen Linn.

Lantern fly family, Fulgoridae

846 Ormenis pruinosa Say

Plant lice, Aphididae

847 **Cherry aphis,** Myzus cerasi Fabr.

848 Pemphigus acerifolii Riley

Water boatmen, Corixidae

849 Corixa interrupta Say

Back swimmers, Notonectidae

850 Notonecta undulata Say

Water scorpions, Nepidae

851 Nepa apiculata Uhl.

Giant water bugs, Belostomidae

852 Belostoma americanum Leidy

853 Zaitha aurantiacum Leidy

Water striders, Hydrobatidae

854 Hygrotrechus conformis Uhl.

855 Limmoporus rufoscutellatus Lat.

Reduviidae

856 **Kissing bug,** Opsicoetus personatus Linn.

857 Acholla multispinosa DeG.

Ambush bugs, Phymatidae

858 Phymata wolffii Stal.

Leaf bugs, Capsidae

859 **Tarnished plant bug,** Lygus pratensis Linn.

860 Calocoris rapidus Say

861 Garganus fusiformis Say

862 Capsus ater Linn.

863 **Four lined leaf bug,** Poecilocapsus lineatus Fabr.

864 Leptopterna dolobrata Linn.

865 Brachytropis calcarata Fall.

Chinch bug family, Lygaeidae

866 Lygaeus turcicus Fabr.

867 **Chinch bug,** Blissus leucopterus Say

Squash bug family, Coreidae

868 **Box elder plant bug,** Leptocoris trivittatus Say

869 **Squash bug,** Anasa tristis DeG.

Stink bug family, Pentatomidae

870 Nezara hilaris Say

871 **Harlequin cabbage bug,** Murgantia histrionica Hahn.

872 Juniper plant bug, *Pentatoma juniperina* Linn.
873 *Euschistus fissilis* Uhl.
874 *Mormidea lugens* Fabr.
875 *Cosmopepla carnifex* Fabr.
876 *Podisus serieventris* Uhl.
877 *P. cynicus* Say

Burrowing bugs, *Cydnidae*

878 *Canthophorus cinctus* Beauv.

Shield-backed bugs, *Scutelleridae*

879 *Eurygaster alternatus* Say

Lice, *Pediculidae*

880 Short-nosed cattle louse, *Haematopinus eurysternus* Nitzsch
881 Hog louse, *Haematopinus urius* Nitzsch

THRIPS, *Physopoda*

882 Onion thrips, *Thrips tabaci* Lind.

GRASSHOPPERS, LOCUSTS, *Orthoptera* (883-903)

Short-horned grasshoppers, *Acrididae*

883 Green striped locust, *Chortophaga viridifasciata* DeG.
884 Clouded locust, *Encoptolophus sordidus* Burm.
885 Carolina locust, *Dissosteira carolina* Linn.
886 Red-legged locust, *Melanoplus femur-rubrum* DeG.
887 Lesser migratory locust, *Melanoplus atlanis* Riley
888 *Melanoplus femoratus* Burm.
889 Coral-winged locust, *Hippiscus tuberculatus* Beauv.
890 Pellucid locust, *Camnula pellucida* Scudd.
891 *Circotettix verruculatus* Scudd.

Long-horned grasshoppers, *Locustidae*

892 Oblong leaf-winged katydid, *Amblycorypha oblongifolia* DeG.

893 Broad-winged katydid, Cyrtophyllus concavus Harris

894 Cone-headed katydid, Conocephalus ensiger Harris

895 Spotted wingless grasshopper, Ceuthophilus maculatus Say

Crickets, Gryllidae

896 Common cricket, Gryllus abbreviatus Serv.

897 Gryllus pennsylvanicus Burm.

898 Long-winged mole cricket, Gryllotalpa columbia Scudd.

Walking sticks, Phasmidae

899 Walking stick, Diapheromera femorata Say

Praying mantis or mule-killer, Mantidae

900 Carolina mantis, Stagmomantis carolina Linn.

Cockroaches, Blattidae

901 Croton bug, Phyllodromia germanica Steph.

902 Cockroach, Periplaneta orientalis Fabr.

903 Wood cockroach, Ischnoptera pennsylvanica DeG.

EARWIGS, Euplexoptera

904 Earwig, Forficula auricularia Linn.

PSOCIDS, Corrodentia

905 Psocus venosus Burm.

TERMITES, Isoptera

906 Termites, Termes flavipes Koll.

STONE FLIES, Plecoptera

907 Leuctra tenella Prov.

908 Leuctra *sp.*

909 Perla ? tristis Hagen

910 Perla *sp.*

911 Pteronarcys ?regalis Newm.

DRAGON FLIES, Odonata

912 Leucorhinia intacta Hagen

913 Diplax rubicundula Say

914 Libellula pulchella Drury
915 L. basalis Say
916 Celithemis eponina Drury
917 Micrathyria berenice Drury
918 Plathemis 3-maculata DeG.
919 Tetragoneuria cynosura Say
920 Aeschna constricta Say
921 Boyeria vinosa Say
922 Cordulegaster erroneus Hagen
923 Enallagma hageni Walsh
924 Argia putrida Hagen
925 Lestes unguiculata Hagen
926 L. rectangularis Say
927 Calopteryx maculata Beauv.

MAY FLIES, Ephemerida

928 Ephemera ?simulans Walk.
929 Pentagenia vittigera Walsh
930 Callibaetis ferruginea Walsh

BRISTLETAILS, SPRINGTAILS, Thysanura

931 Bristletail fishmoth, Thermobia furnorum Rov.

PROTECTIVE MIMICRY (932-46)

Collection prepared and mounted by the Denton Bros., Wellesley Mass.

932 Danais tytia Gray (India). This insect is protected from the birds by an unpleasant odor or taste, and it is mimicked by 933, which is not distasteful to birds.

933 Papilio agestor Gray (India). This insect departs widely from the general appearance of most of its close relatives. Its resemblance to 932 undoubtedly protects it from molestation by birds.

934 Hebomoia glaucippe Linn. (China). Under surface; note its resemblance to the skeleton of a leaf.

935 Hypolimnas misippus Linn. (India). The female mimics 937, which is protected from birds by an unpleasant odor or taste. Compare with the male, 939.

936 Erebomorpha sp. (India). Note light and shadow effect, which is probably protective.

937 Danais chrysippus Linn. (India). Protected by an unpleasant odor or taste and mimicked by 935.

938 Hebomoia glaucippe Linn. (China). Upper surface; compare with 934.

939 Hypolimnas misippus Linn. (India). Male, not protected by mimicry; compare with female, 935.

940 **Monarch butterfly,** Anosia plexippus Linn. (North America). A native, very common species, having an unpleasant odor or taste and therefore not eaten by birds. It is mimicked by 941.

941 **Viceroy,** Basilarchia archippus Cram. (North America). Mimics 940 and differs greatly in general appearance from its close relatives.

942 Kallima inachis Boisd. (India). Leaf butterfly, under surface; note resemblance to brown leaves and also the imitation of fungous spots.

943 Kallima inachis Boisd. (India). Leaf butterfly. One showing upper surface of wings; compare with 942. And the other showing a butterfly in its resting position on a bare twig, it resembling a brown leaf very closely when in this position.

944 Attacus atlas Linn. (India). The tip of the wings resembles a cobra's head.

945 Catocala concumbens Walk. (North America). One specimen is spread, showing the highly colored hind wings and the other is mounted on a piece of bark in its resting position. Note how inconspicuous the latter is.

946 Caligo *sp.* (South America). The specimen is shown reversed, a position in which it resembles the head of an owl.

NEW YORK BEAUTIES (947-61)

This collection shows a few of our more beautiful native forms. Prepared and mounted by Denton Bros., Wellesley Mass.

947 **Red admiral,** Vanessa atalanta Linn. Under surface; compare with 950, showing the upper surface of the same insect.

948 **Mountain silver spot,** Argynnis atlantis Edw.

949 **Black swallowtail,** Papilio polyxenes Fabr. Under surface; compare with 952.

950 **Red admiral,** Vanessa atalanta Linn. Upper surface; compare with 947.

951 **Regal fritillary,** Speyeria idalia Drury.

952 **Black swallowtail,** Papilio polyxenes Fabr. Upper surface; compare with 949.

953 **Eight spotted forester,** Alypia 8-maculata Hübn. A common species about grapevine and Virginia creeper.

954 **Luna moth,** Tropaea luna Linn. A somewhat common moth.

955 **Imperial moth,** Basilona imperialis Drury. A rare moth in New York state.

956 Catocala nubilis, Hübn.

957 **Mourning cloak butterfly,** Euvanessa antiopa Linn. Very common, and in some sections of the state it is a serious pest of willow, poplar and elm trees.

958 **Triptogon modesta** Harris

959 **Thyreus abbotii** Swains

960 **Io moth,** Automeris io Fabr.

961 **Promethea moth,** Callosamia promethea Drury.

TECHNICAL COLLECTION (962-1021)

PREPARED BY C. S. BANKS

Cyanid bottles

962 Empty bottle

963 Bottle with cyanid

964 Bottle with cyanid and plaster

965 Bottle complete

966 Paper shavings in bottle

967 Chloroform bottle with brush

968 Collecting vials

969 Pill boxes

Butterfly papers

970 First fold

971 Second fold

972 Butterfly in position

973 Closed fold
974 Insect pins
975 Pin holder
976 Pinning block
977 Collecting net showing construction. For model *see* wing frame and wall.
978 Dip net, *see* model on wall
979 Mounts for small insects
980 Capsule mount
981 Glue for mounting insects[1]
982 Coleoptera mount
983 Hemiptera mount
984 Orthoptera mount
985 Locality and date labels

Mount by Denton method

986 Plaster cast
987 Mount complete

Alcoholic preparations

988 Bottle with label
989 Bottle with pin
990 Bottle on block
991 Pinning forceps
991a Forceps for handling insects
992 Sheet cork
993 Sheet peat
994 Relaxing device, *see* photograph in wing frame
995 Spreading apparatus
996 Spreading pins with handles
997 Strips used in spreading, mica, paper and glass
998 For spreading Microlepidoptera
999 Dr Lintner's device
1000 For spreading Hymenoptera
1001 For spreading Coleoptera

---

1 Formula: Crush 75 to 100 grams of gelatin or clear glue, preferably the former, and put in a bottle with 100 cubic centimeters of commercial acetic acid (no. 8) and set in a warm place for three or more days, shaking occasionally. Then add 100 cc of water, 100 cc of 95% alcohol and 15 to 20 cc of glycerin. Operations may be hastened by heating the glue and acid in a water bath, but *great care* must be exercised if this is done.

For inflating larvae

1002 Larva on blowtube
1003 Drying ovens and tubes
1004 Wire mount on pin
1005 Wire mount complete
1006 Pocket lens
1007 Tripod lens

Insect pests of collections

1008 Anthrenus verbasci Linn.
1009 A. verbasci larva
1010 Attagenus piceus Oliv.
1011 Dermestes lardarius Linn.

Preventives and remedies for pests in collections

1012 Naphthalin cone
1013 Naphthalin ball
1014 Carbon bisulfid
1015 Verdigris on insect

Insect cases

1016 Green box
1017 Schmidt box
1018 Dr Lintner's Coleoptera box
1019 Corner Section insect case (United States national museum style)

Shipping devices

1020 Bottle in mailing tube
1021 Small box properly packed

FRAMED PHOTOGRAPHS

1022 "Bug house," where Dr Fitch did most of his work, Fitch's Point, Salem N. Y., photograph, 19 Sep. 1900.

1023 Asa Fitch M. D., entomologist State agricultural society, 1854-72.

1024 Residence of Dr Fitch, Fitch's Point, Salem N. Y., photograph, 19 Sep. 1900.

1025 Joseph Albert Lintner Ph.D., New York state entomologist, 1874-98.

1026 View of main portion of office of state entomologist, 1901.

Wing frames

1027 Photographs of private office of state entomologist, of the north wing and dark room in the general office, of trays of classified and unclassified insects. Table of correspondence during the past five years and a note on the state collection.

1028 Staff of the entomologic division of state museum. Table of Fitch reports, list of principal publications of state entomologist, and a note on additional publications.

1029 Blank forms used in office of state entomologist. Official paper, entomologic field station paper, official postal card, price list of publications, voluntary observer appointment blank, accession slip, receipt slip, locality and date label sheet, gummed labels, special printed labels, blank labels.

1030-31 Title pages of entomologic publications.

1032 Original figures from museum bulletins 26, 37 and a few others.

1033 Photographs of inflating, relaxing apparatus and work table in the general office.

1034 Pattern of butterfly net.

1035 Voluntary observer paper and list of voluntary observers for 1901.

1036 Map showing location of voluntary observers.

1037 Four anatomic plates, showing the structural details of Chloropisca variceps (fig. 7, 7th rep't), Phora agarici (pl. 2, 10th rep't), scorpion flies (pl. 4, 10th rep't) and of Diplosis cucumeris (pl. 2, 11th rep't).

1038 Miscellaneous plates as follows: upper austral life zone in New York (pl. 4, 11th rep't), cottonwood leaf beetle collecting machine (pl. 6, 11th rep't), illustrations of 17 year cicada (pl. 9 and 10, 12th rep't), and the great white leopard moth (pl. 1, 12th rep't).

1039 Three plates as follows: Work of forest tent-caterpillars in sugar orchard (fig. 4 in special paper on insects injurious to maple trees); forest tent-caterpillars on appletrees (pl. 15 and 16, 16th rep't).

1040 Miscellaneous plates as follows: gipsy moth (pl. 1, 16th rep't), palmer worm (pl. 2, 16th rep't), work of *Scolytus rugulosus* (pl. 14, 16th rep't), fumigating tent (pl. 13, 16th rep't).

1041 Shade tree pests as follows: maple and elm tree borers (pl. 7, 12th rep't), elm bark louse and work of elm leaf beetle (pl. 2, mus. bul. 27), spraying outfit in operation (fig. 3 in special paper on insects injurious to maple trees).

1042 Insects injurious to mapletrees: white marked tussock moth and forest tent-caterpillar (pl. 1 in special paper), leopard moth and maple sesian (pl. 2 in special paper), sugar maple borer, mapletree pruner and cottony mapletree scale insect (pl. 3 of special paper).

1043 Fruit tree and household pests: appletree tent-caterpillar (pl. 1), codling moth (pl. 3, 4), bedbug, red ant, larder beetle and croton bug (pl. 6). All the plates exhibited under this number were published in the transactions of the New York state agricultural society, 1899, and they illustrate a paper on injurious farm and household insects.

1044 Insecticides, results obtained with (pl. 4-7, 16th rep't).

1045 Insecticides, results obtained with (pl. 8, 9, 10 and 11, 16th rep't).

1046 Technical characters of scale insects, *Aspidiotus perniciosus*, *A. ancylus*, *A. forbesi* and *A. ostreaeformis* (pl. 11-15 of Museum bulletin 46).

1047 Aquatic insects, four colored plates representing some of the more important insects occurring in the Adirondacks (pl. 10-13 of Museum bulletin 47).

1048 Aquatic insects, two colored plates and two black and white plates illustrating methods of collecting and character of one locality (pl. 5, 6, 14 and 15 of Museum bulletin 47).

1049 Aquatic insects and their home (pl. 4, 9, 17 and 18 of Museum bulletin 47).

1050 Dragon flies and other insects (pl. 21, 23, 24 and 26 of Museum bulletin 47).

1051 Caddis flies and fish flies (pl. 27, 30-32 of Museum bulletin 47).

1052 Caddis flies and Diptera (pl. 33-36 of Museum bulletin 47).

PUBLICATIONS

Noxious, beneficial and other insects of the state of New York, reports 1-14, by Asa Fitch M. D., entomologist of the New York state agricultural society. Two volumes, half morocco.

Lintner entomologic publications, comprising Entomologic contributions 1-4; Report on the insect and other animal forms of Caledonia creek, New York; Report on the injurious insects of the year 1878; Insects of the clover plant; A new principle in protection from insect attack; Some injurious insects of Massachusetts; White grub of the May beetle; Our insect enemies and how to meet them; Late experiences with insects injurious to the orchard and garden, 1890; Report of the committee on entomology, 1891; Report of the committee on entomology, 1893; Report of the state entomologist for the year 1893. One volume, half morocco.

Injurious and other insects of the state of New York, reports 1-13, by J. A. Lintner, state entomologist. Four volumes, half morocco.

New York state museum bulletins

20 Elm leaf beetle in New York state, by E. P. Felt, acting state entomologist.

23 14th report of the state entomologist, by E. P. Felt, acting state entomologist.

24 Memorial of life and entomologic work of Joseph Albert Lintner Ph. D., state entomologist, 1874-98. Supplement to 14th report of the state entomologist, by E. P. Felt, state entomologist.

26 Collection, preservation and distribution of New York insects, by E. P. Felt, state entomologist.

27 Shade tree pests in New York state, by E. P. Felt, state entomologist.

31 15th report of the state entomologist, by E. P. Felt, state entomologist.

36 16th report of the state entomologist, by E. P. Felt, state entomologist.

37 Illustrated descriptive catalogue of some of the more important injurious and beneficial insects of New York state, by E. P. Felt, state entomologist. All the bulletins except no. 36 were bound in one half morocco volume.

EXPLANATION OF PLATES

PLATE 1

Hessian fly Cecidomyia destructor Say

A wheat plant showing an uninjured stalk at the left and one infested with the Hessian fly at the right. The leaves of the latter are dwarfed and withered and the stem is swollen at three points near the ground where the "flaxseeds" are located between the leaf sheath and the stem.

a Egg of Hessian fly greatly enlarged as are all figures except *e* and *h*

b Larva, its natural size indicated by the line beside it

c Puparium, "flaxseed" or pupal case

d Pupa

e Adult female ovipositing on leaf, natural size

f Adult female, very much enlarged

g Male, very much enlarged

h "Faxseeds" in position between leaf sheath and stem

i Parasite, Merisus destructor, male, much enlarged

All from Packard, U. S. ent. com. 3d rep't, *b* drawn by Dr Riley, *d* and *f* by Mr Burgess, *a*, *g*, *c* and *i* by Prof. Packard.

PLATE 2

European willow gall midge

Rhabdophaga salicis Schrk.

FIG.

1 Breast bone of larva

2 Dorsal view of pupal case, showing setaceous processes

3 Distal segment of tarsus, showing claws and pulvillus from side

FIG.

4 Pulvillus

5 Two segments of antenna of male

6 Two segments of antenna of female. All very greatly enlarged

PLATE 3

Leopard moth

Zeuzera pyrina Linn.

1 Larva and castings

2 Empty pupal case

3 Female moth at rest. All on a badly bored piece of wood

PLATE 4

1 Gall of Rhabdophaga salicis Schrk. on European willow

2 Lecanium nigrofasciatum (After Pergande, U. S. dep't agric. div. ent. Bul. 18 new series '98. p. 27)

3 Rose scale insect, Aulacaspis rosae Sandb., on blackberry, enlarged

4 Male, female and young scale, very much enlarged

5 Birch leaf Bucculatrix, Bucculatrix canadensisella: *a* skeletonized leaf; *b* molting cocoon; *c* larva; *d* head of larva; *e* anal segments of larva; *f* same of pupa; *g* cocoon with extruded pupa skin; *h* moth—all enlarged. (From *Insect life*)

PLATE 5

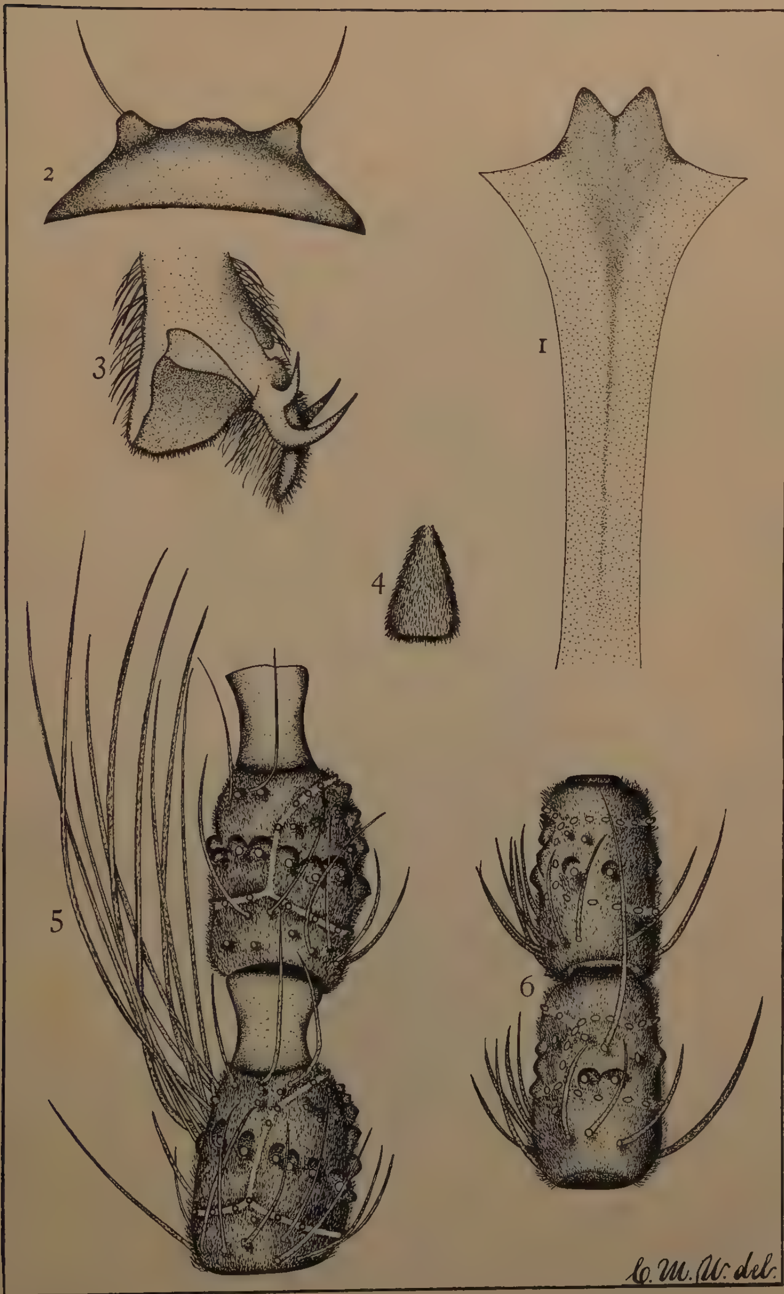
General view of experimental orchard showing thrifty appearance of young trees infested with San José scale, showing how the pest has been controlled by spraying. Photo 8 Oct. 1901

PLATE 6

Young orchard in bad condition on account of San José scale and yet it became infested later than the orchard represented on pl. 5 but prior to date had not been sprayed. Photo 8 Oct. 1901.

Plate 1

Hessian fly



European willow gall midge

Plate 3

Leopard moth

1

4

2

5

3

Photo 8 Oct. 1901

Experimental orchard, showing value of spraying, compare with pl. 6

Photo 8 Oct. 1901

Unsprayed, San José scale infested orchard, compare with pl. 5

INDEX

The superior figures tell the exact place on the page in ninths; e. g. 803^{3} means page 803, beginning in the third ninth of the page, i. e. about one third of the way down.

(*Pages 927-8 were bulletin cover pages*)

Published monthly by the

BULLETIN 271 University of the State of New York NOVEMBER 1902

New York State Museum

FREDERICK J. H. MERRILL Director
CHARLES H. PECK State Botanist

Bulletin 54

BOTANY 5

REPORT OF THE STATE BOTANIST 1901

BY

CHARLES H. PECK M.A.

University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director
CHARLES H. PECK State Botanist

Bulletin 54
BOTANY 5

REPORT OF THE STATE BOTANIST 1901

To the Regents of the University of the State of New York

I have the honor of submitting to you the report of work done in the botanical department of the state museum during the year 1901.

Specimens of plants for the herbarium have been collected in the counties of Albany, Essex, Franklin, Rensselaer, Warren and Washington. Specimens have been received from correspondents, either as contributions or for identification, that were collected in the counties of Albany, Columbia, Chautauqua, Essex, Franklin, Herkimer, Monroe, Oneida, Onondaga, Ontario, Schoharie, St Lawrence, Warren and Washington. The number of species of which specimens have been collected and added to the herbarium is 374. Of these, 57 were not before represented in it. Of the newly represented species, 37 are found in the collections of the botanist, 20 in those of his correspondents, and of the whole number, 16 are considered new to science and are described as such in the following pages. All of these are fungi and with one exception belong to the collections of the botanist. Specimens of the remaining 317 species make the representation of these species more complete and satisfactory. Of these, 282 belong to the collections of the botanist and 35 to those of his correspondents. A list of the names of the added species is marked **A**.

The number of those who have contributed specimens for the herbarium or for identification is 34. Of these, 14 have sent extralimital specimens. A list of the names of the contributors and of their respective contributions is marked **B**.

A record of species not before reported, with notes concerning them, time and place of collecting the specimens and descriptions of new species is marked **C.**

A part of the report containing remarks on previously recorded species and descriptions of new varieties is marked **D.**

The investigation of our edible species of mushrooms has been continued. Of those whose edible qualities have been tried, 11 species have been thought worthy of addition to the list of edible fungi. Descriptions of these may be found in a part of the report marked **E.** Colored figures of these and also of seven of the new species have been prepared.

At the request of the director of the state museum a botanical exhibit was prepared for the Pan-American exposition at Buffalo. But little time was given for the preparation of this exhibit, yet specimens were selected from material on hand that should fairly represent the herbarium, and the principal divisions and groups of plants that constitute our state flora. Seed-bearing or flowering plants, ferns and fern allies, mosses, lichens, marine algae and fungi were all represented by specimens of one or more species. So far as possible, specimens were selected that have more or less economic importance and therefore popular interest, because of some utility of the plants themselves or of some of their products, or because of some injurious character either as troublesome weeds or harmful or destructive parasites or saprophytes. Among the parasitic fungi the smuts were represented by several species because they are so injurious to our crops of cereals. Among saprophytic fungi those destructive to wood and also those valued for their edibility were specially represented. The specimens placed on exhibition have been safely returned to the herbarium, but those of the seed-bearing plants have suffered a little deterioration in appearance because of their long exposure to strong light. Their green color has faded.

The herbarium has been moved from the capitol to geological hall where it has a place far more suitable, more commodious, better lighted, more convenient for botanical work and more accessible to the public. Thanks are due to all who have aided in bringing about this change. It is very desirable that it may not again be necessary to store any part of it where it may not

be under the immediate control of the botanist in charge. Such a condition of things, as in the present case, is very likely to result in injury to or loss of specimens. Some of the stored specimens were destroyed by insects, some by moisture, having been placed apparently where they became wet by a leak in the roof. A glass case containing puff balls was broken and its contents spoiled or destroyed, and two boxes, one containing specimens and the other mushroom models, could not be found.

The room in geological hall which has been assigned to the botanical department is on the second floor in the southern extension of the building. It is divided into two parts, the front part being used as a show room and containing the sections of the trunks of our trees arranged in wall cases, and photographs and thin sections of the wood of the trees exhibited in swinging frames supported by upright standards. It is expected also to contain table cases in which will be exhibited specimens of our edible and poisonous mushrooms and other plants or parts or products of plants that may have such importance or economic value as to be of special public interest. The rear part of the room contains the office of the botanist, the library, the herbarium and duplicate specimens together with specimens of extralimital species. It will also be used in part as a botanical workroom.

Several species of thorn recently described, having been reported as occurring at Crown Point, that locality was visited late in May with the purpose of collecting flowering specimens for the herbarium. The thorn shrubs and small trees were found in abundance along the northern and western shores of the promontory, and about the ruins of the old fort. Their leaves were generally badly infested by plant lice, a condition which it is said is repeated every year. The cockspur thorn is the prevailing species and was in better condition than the others. The large fruited thorn, Crataegus punctata, the long spined thorn, C. macracantha, the Champlain thorn, C. champlainensis, Pringle's thorn, C. pringlei, and the pruinose fruited thorn, C. pruinosa, were found there.

The last three are additions to the previously known species of our flora. The red seeded dandelion, Taraxacum ery-

throspermum, and the flickweed, Sophia sophia, were also found there and are additions to our flora.

In July a trip was made to North Elba, specially to visit Mt Clinton and the southeastern cliffs of Mt Wallface. Mt Clinton is the most southern of the three prominent peaks in the Mt McIntyre range and so far as known to me had never been visited by any botanist. Its open summit was found to be less extensive than had been anticipated and it furnished no additions to our flora. The alpine juniper, Juniperus communis alpina, was found there in greater abundance than on the higher summit of Mt McIntyre and was fruiting sparingly. The dwarf paper birch, Betula papyracea minor, was also abundant and fruiting freely though only 2 or 3 feet high. The arbor vitae, Thuja occidentalis, in a dwarf irregular form ascends to the open summit of the mountain.

On the southeastern cliffs of Mt Wallface the twisted whitlow-grass, Draba incana arabisans, was found in abundance in fruiting condition. It probably flowers here in June. Fine fruiting specimens of the spiked wood-rush were associated with it. This had been previously discovered on the top of Mt Wallface. This mountain is at present the only locality known to me in our state where these two plants are found.

In August, Bolton and the surrounding region on the west shore of Lake George was explored botanically and found to be prolific in fungi. Showers had been frequent and weather conditions were favorable to the growth of mushrooms. In this visit and a subsequent one in September, which was extended northward to Hague, many species of fungi were added to the list of New York plants and several were tried and found worthy of addition to our list of edible mushrooms.

Respectfully submitted

Charles H. Peck

State botanist

Albany, 17 Dec. 1901

A

PLANTS ADDED TO THE HERBARIUM

New to the herbarium

Conringia orientalis (*L.*) *Dumort.*
Geum vernum *T. & G.*
Crataegus champlainensis *Sarg.*
C. pringlei *Sarg.*
C. holmesiana *Ashe*
C. pruinosa *Wend.*
Vernonia gigantea (*Walt.*) *Britton*
Antennaria parl. arnoglossa *Fern.*
Centaurea jacea *L.*
Lactuca morssii *Robins.*
Taraxacum erythrospermum *Andrz.*
Hedeoma hispida *Pursh*
Panicularia laxa *Scribn.*
Mylia anomala (*Hook.*) *S. F. Gray*
Scapania irrigua (*Nees*) *Dumort.*
Cetraria aurescens *Tuckm.*
Stereocaulon denudatum *Fl.*
Endocarpon fluviatile *DC.*
Pannaria leucosticta *Tuckm.*
Lepiota adnatifolia *Pk.*
Tricholoma rimosum *Pk.*
Clitocybe regularis *Pk.*
C. subconcava *Pk.*
Pleurotus minutus *Pk.*
Lactarius foetidus *Pk.*
Hygrophorus glutinosus *Pk.*
Volvaria speciosa *Fr.*
V. hypopithys *Fr.*
Cortinarius submarginalis *Pk.*
C. obliquus *Pk.*
Cortinarius violaceo-cinereus (*Pers.*) *Fr.*
Boletus multipunctus *Pk.*
Fistulina pallida *B. & R.*
Poria myceliosa *Pk.*
Hydnum umbilicatum *Pk.*
Thelephora exigua *Pk.*
T. multipartita *Schw.*
Corticium portentosum *B. & C.*
C. arachnoideum *Berk.*
Peniophora parasitica *Burt*
P. affinis *Burt*
Asterostroma bicolor *E. & E.*
Clavaria bicolor *Pk.*
Phallogaster saccatus *Morg.*
Cyathus lesueurii *Tul.*
Didymium fairmani *Sacc.*
Physarella multiplicata *Macb.*
Empusa grylli *Fresen.*
Marsonia pyriformis (*Riess*) *Sacc.*
Septoria polygonina *Thum.*
Chalara paradoxa (*Seynes*) *Sacc.*
Colletotrichum antirrhini *Stewart*
C. rudbeckii *Pk.*
Helvella adhaerens *Pk.*
Lachnella corticalis (*Pers.*) *Fr.*
Anthostoma dryophilum (*Curr.*) *Sacc.*
Mycenastrum spinulosum *Pk.*

Not new to the herbarium

Clematis virginiana *L.*
Trollius laxus *Salisb.*
Ranunculus bulbosus *L.*
Hepatica acuta (*Pursh*) *Britton*
Berberis vulgaris *L.*
Podophyllum peltatum *L.*
Castalia tuberosa (*Paine*) *Greene*
Arabis hirsuta (*L.*) *Scop.*
Dentaria laciniata *Muhl.*
D. maxima *Nutt.*
Draba incana arabisans *Mx.*
Xanthoxylum americanum (*Mill.*)
Rhus copallina *L.*
Vaccaria vaccaria (*L.*) *Britton*
Lychnis flos-cuculli *L.*
Malva sylvestris *L.*

Amorpha fruticosa *L.*
Meibomia paniculata (*L.*) *Kuntze*
Vicia tetrasperma (*L.*) *Moench*
Cassia marylandica *L.*
Polygala viridescens *L.*
Spiraea salic. latifolia *Ait.*
Potentilla arguta *Pursh*
Rubus strigosus *Mx.*
Crataegus macracantha *Lodd.*
C. modesta *Sarg.*
Ludwigia alternifolia *L.*
Chamaenerion angustifolium (*L.*) *Scop.*
Onagra biennis (*L.*) *Scop.*
Ilex verticillata (*L.*) *Gray*
Viburnum pauciflorum *Pylaie*
Galium verum *L.*
Valerianella chenopodifolia (*Pursh*) *DC.*
Aster vimineus *Lam.*
A. lateriflorus (*L.*) *Britton*
Solidago juncea *Ait.*
S. caesia *L.*
Galinsoga parviflora *Cav.*
Antennaria neodioica *Greene*
Lactuca spicata (*Lam.*) *Hitch.*
L. spi. integrifolia (*Gr.*) *Hitch.*
Onopordon acanthium *L.*
Rudbeckia triloba *L.*
Gaylussacia resinosa (*Ait.*) *T. & G.*
Kalmia angustifolia *L.*
Lysimachia terrestris (*L.*) *B. S. P.*
Conopholis americana (*L.*) *Wallr.*
Dianthera americana *L.*
Cuscuta epithymum *Murr.*
Scrophularia leporella *Bickn.*
Pentstemon pentstemon (*L.*) *Britton*
Solanum carolinense *L.*
Tetragonanthus deflexus (*Sm.*) *Kuntze*
Monarda fistulosa *L.*
Euphorbia platyphylla *L.*
Myosotis verna *Nutt.*
Chenopodium anthelminticum *L.*
Betula pap. minor *Tuckm.*
Hickoria minima (*Marsh.*) *Britton*
Juniperus com. alpina *Gaud.*
Potamogeton lonchites *Tuckm.*
P. obtusifolius *M. & K.*
Gyrostachys gracilis (*Bigel.*) *Kuntze*
G. romanzoffiana (*Cham.*) *MacM.*
Streptopus amplexifolius (*L.*) *DC.*
Clintonia borealis (*Ait.*) *Raf.*
Juncoides spicatum (*L.*) *Kuntze*
Eleocharis ovata (*Roth*) *R. & S.*
E. diandra *Wright*
Eriophorum virginicum *L.*
Scirpus peckii *Britton*
S. rubrotinctus *Fern.*
S. atrocinctus *Fern.*
Rhynchospora glomerata (*L.*) *Vahl*
Fimbristylis autumnalis (*L.*) *R. & S.*
Hemicarpha micrantha (*Vahl*) *Britton*
Panicum dichotomum *L.*
Agrostis alba *L.*
Poa flava *L.*
Panicularia canadensis (*Mx.*) *Kuntze*
Muhlenbergia mexicana (*L.*) *Trin.*
Homalocenchrus oryzoides (*L.*) *Poll.*
Dryopteris noveboracensis (*L.*) *Gray*
D. spin. dilatata (*Hoffm.*) *Underw.*
Woodsia obtusa *Torr.*
Botrychium lanceolatum *Angst.*
B. matricariaefolium *A. Br.*
B. obliquum *Muhl.*
B. dissectum *Spreng.*
Equisetum lit. gracile *Milde*
Lycopodium annotinum *L.*
L. tristachyum *Pursh*
Sphagnum pylaesii *Brid.*
Dicranum elongatum *Schwaegr.*
Tetraphis pellucida *Hedw.*
Hedwigia ciliata *Ehrh.*
Polytrichum strictum *Banks.*
Riccia fluitans *L.*
Marchantia polymorpha *L.*
Theloschistes parietinus (*L.*) *Norm.*

Cetraria islandica *(L.) Ach.*
C. nivalis *Ach.*
Baeomyces aeruginosus *(Scop.) DC.*
Stereocaulon paschale *(L.) Fr.*
Cladonia deformis *(L.) Hoffm.*
C. cristatella *Tuckm.*
C. cornucopioides *(L.) Fr.*
C. uncialis *(L.) Fr.*
C. rangiferina *(L.) Hoffm.*
Calicium subtile *Pers.*
Amanita phalloides *Fr.*
A. frostiana *Pk.*
A. spreta *Pk.*
A. musc. formosa *(G. & R.) Fr.*
Amanitopsis volvata *(Pk.) Sacc.*
A. vaginata *(Bull.) Roze*
Lepiota friesii *Lasch.*
L. acutesquamosa *Weinm.*
L. felina *Pers.*
L. granulosa *Batsch*
L. rugosoreticulata *Lorin.*
L. cristatella *Pk.*
L. illinita *Fr.*
Tricholoma russula *(Schaeff.) Fr.*
T. rutilans *(Schaeff.) Fr.*
T. variegatum *(Scop.) Fr.*
T. tricolor *Pk.*
T. peckii *Howe*
T. fallax *Pk.*
T. alboflavidum *Pk.*
T. fuligineum *Pk.*
T. album *(Schaeff.) Fr.*
Clitocybe anisaria *Pk.*
C. dealbata *Sow.*
C. infundibuliformis *(Schaeff.)*
C. adirondackensis *Pk.*
C. laccata *(Scop.) Fr.*
C. ochropurpurea *Berk.*
Collybia radicata *(Relh.) Fr.*
C. platyphylla *Fr.*
C. maculata *(A. & S.) Fr.*
C. butyracea *(Bull.) Fr.*
C. dryophila *(Bull.) Fr.*
C. esculentoides *Pk.*
C. velutipes *(Curt.) Fr.*
Collybia confluens *(Pers.) Fr.*
Mycena immaculata *Pk.*
M. galericulata *(Scop.) Fr.*
M. pseudopura *Cke.*
Omphalia umbellifera *(L.) Fr.*
O. atratoides *Pk.*
O. fibula *(Bull.) Fr.*
O. swartzii *Fr.*
O. camp. sparsa *Pk.*
Hygrophorus laurae *Morg.*
H. pratensis *(Pers.) Fr.*
H. chlorophanus *Fr.*
H. nitidus *B. & C.*
Lactarius cilicioides *Fr.*
L. indigo *(Schw.) Fr.*
L. chelidonium *Pk.*
L. subpurpureus *Pk.*
L. aquifluus *Pk.*
L. theiogalus *(Bull.) Fr.*
L. chrysorrheus *Fr.*
L. pyrogalus *(Bull.) Fr.*
L. alpinus *Pk.*
L. camphoratus *(Bull.) Fr.*
Russula decolorans *Fr.*
R. rugulosa *Pk.*
Cantharellus floccosus *Schw.*
C. umbonatus *Fr.*
C. lutescens *Fr.*
Nyctalis asterophora *Fr.*
Marasmius peronatus *Fr.*
M. subnudus *(Ellis) Pk.*
M. semihirtipes *Pk.*
M. spongiosus *B. & C.*
M. impudicus *Fr.*
Lentinus ursinus *Fr.*
L. lepideus *Fr.*
Panus stipticus *(Bull.) Fr.*
Lenzites bet. radiatus *Pk.*
L. sepiaria *Fr.*
L. vialis *Pk.*
Entoloma sinuatum *Fr.*
E. sericeum *(Bull.) Fr.*
Clitopilus micropus *Pk.*
C. abortivus *B. & C.*
Pholiota squarrosa *Mull.*

Pholiota praecox *Pers.*
Inocybe infelix *Pk.*
I. geophylla *Sow.*
Stropharia aeruginosa (*Curt.*) *Fr.*
Hypholoma incertum *Pk.*
H. aggre. sericeum *Pk.*
Cortinarius berlesianus *Sacc.*
C. sublateritius *Pk.*
Boletinus pictus *Pk.*
Boletus bicolor *Pk.*
B. chrys. deformatus *Pk.*
B. pallidus *Frost*
B. variipes *Pk.*
B. eximius *Pk.*
B. ornatipes *Pk.*
B. felleus *Bull.*
B. cyanescens *Bull.*
Fistulina hepatica *Fr.*
Polyporus ovinus (*Schaeff.*) *Fr.*
P. poripes *Fr.*
P. confluens (*A. & S.*) *Fr.*
P. resinosus (*Schrad.*) *Fr.*
P. chioneus *Fr.*
P. adustus (*Willd.*) *Fr.*
P. gilvus *Schw.*
Gloeoporus conchoides *Mont.*
Fomes lucidus (*Leys*) *Fr.*
F. applanatus (*Pers.*) *Wallr.*
F. fomentarius (*L.*) *Fr.*
F. roseus (*A. & S.*) *Fr.*
F. conchatus (*Pers.*) *Fr.*
Polystictus radiatus *Fr.*
P. hirsutus *Fr.*
P. pergamenus *Fr.*
P. pseudopergamenus (*Thum.*)
Poria subacida *Pk.*
P. mutans *Pk.*
Trametes trogii *Berk.*
T. sepium *Berk.*
T. serialis *Fr.*
T. cinnabarina (*Jacq.*) *Fr.*
Daedalea confragosa *Pers.*
D. unicolor *Fr.*
Cyclomyces greenii *Berk.*
Caldesiella ferruginosa (*Fr.*) *Sacc.*
Hydnum scrobiculatum *Fr.*
H. zonatum *Batsch*
H. vellereum *Pk.*
H. septentrionale *Fr.*
Irpex lacteus *Fr.*
I. ambiguus *Pk.*
Mucronella min. conferta *Pk.*
Craterellus lutescens (*Pers.*) *Fr.*
C. cornucopioides (*L.*) *Pers.*
C. cantharellus (*Schw.*) *Fr.*
Thelephora caryophyllea (*Schaeff.*) *Pers.*
Stereum fasciatum *Schw.*
S. complicatum *Fr.*
Hymenochaete tabacina (*Sow.*) *Lev.*
Corticium evolvens *Fr.*
C. alutaceum (*Schrad.*)
C. investiens (*Schw.*)
C. lilacino-fuscum *B. & C.*
Guepinia spathularia (*Schw.*) *Fr.*
Clavaria flava *Schaeff.*
C. cristata *Pers.*
C. gracilis *Pers.*
C. pyxidata *Pers.*
C. circinans *Pk.*
C. pinophila *Pk.*
C. aurea *Schaeff.*
C. pulchra *Pk.*
Physalacria inflata (*Schw.*) *Pk.*
Phallus ravenelii *B. & C.*
Cyathus striatus (*Huds.*) *Hoffm.*
Bovista plumbea *Pers.*
Scleroderma vulgare *Hornem.*
S. verrucosum (*Bull.*) *Pers.*
Calvatia cyathiformis (*Bosc.*)
Lycoperdon gemmatum *Batsch*
L. pyriforme *Schaeff.*
L. subincarnatum *Pk.*
L. cruciatum *Rost.*
L. frostii *Pk.*
L. curtisii *Berk.*
Fuligo ovata (*Schaeff.*) *Macb.*
Tubifera ferruginosa (*Batsch*) *Macb.*
Reticularia lycoperdon *Bull.*
Spumaria alba (*Bull.*) *DC.*

Physarum compressum *A. & S.*
Tilmadoche viridis (*Bull.*) *Sacc.*
Diachaea leucopoda (*Bull.*) *R.*
D. subsessilis *Pk.*
Didymium melanospermum (*Pers.*) *Macb.*
Stemonitis fusca (*Roth*) *R.*
S. smithii *Macb.*
Comatricha stemonitis (*Scop.*) *Sheldon*
C. aequalis *Pk.*
Dictydium cancellatum (*Batsch*)
Lachnobolus globosus (*Schw.*) *R.*
Arcyria cinerea (*Bull.*) *Pers.*
A. denudata (*L.*) *Sheldon*
A. nutans (*Bull.*) *Grev.*
Hemitrichia vesparium (*Batsch*)
Trichia favoginea (*Batsch*) *Pers.*
Uredo polypodii (*Pers.*) *DC.*
Coleosporium solidaginis (*Schw.*)
Melampsora farinosa (*Pers.*) *Schroet.*
Ustilago zeae (*Beckm.*) *Ung.*
U. utriculosa (*Nees*) *Tul.*
U. anomala *Kze.*
Septoria irregularis *Pk.*
S. acerina *Pk.*
Pilacre faginea (*Fr.*) *B. & Br.*
Monilia fructigena *Pers.*
Ramularia tulasnei *Sacc.*
Glomerularia corni *Pk.*
Spathularia crispa *Pk.*
S. clavata (*Schaeff.*)
Leotia lubrica (*Scop.*) *Fr.*
Helvella infula *Schaeff.*
H. gracilis *Pk.*
Vibrissea truncorum (*A. & S.*)
Lachnella citrina *Pk.*
Dasyscypha bicolor (*Bull.*) *Fckl.*
Phyllachora pteridis (*Reb.*) *Fckl.*
Rhytisma acerinum (*Pers.*) *Fr.*
Hypoxylon perforatum *Schw.*

B

CONTRIBUTORS AND THEIR CONTRIBUTIONS

Mrs N. L. Britton, New York

Gymnostomum rupestre *Schwaegr.*
Seligeria doniana (*Sw.*) *All.*
Dicranella heteromalla *Schp.*
Dicranum fulvum *Hook.*
D. flagellare *Hedw.*
Didymodon rubellus *B. & S.*
D. riparius *Aust.*
Grimmia apocarpa *Hedw.*
Hedwigia ciliata *Ehrh.*
Amphoridium lapponicum *Schp.*
Drummondia clavellata *Hook.*
Ulota hutchinsiae *Schp.*
Tetraphis pellucida *Hedw.*
Bartramia pomiformis *Hedw.*
Philonotis fontana *Brid.*
Bryum roseum *Schreb.*
Webera albicans *Schp.*
Mnium affine *Bland.*
M. punctatum *Hedw.*
M. elatum *B. & S.*
M. spinulosum *B. & S.*
Pogonatum alpinum *Roehl.*
Diphyscium foliosum *Mohr.*
Fontinalis antip. gigantea *Sull.*
Leptodon trich. immersus *Sull.*
Homalia jamesii *Schp.*
Myurella careyana *Sull.*
Anomodon rostratus *Schp.*
A. attenuatus *Hueben.*
A. viticulosus *H. & T.*
Cylindrothecium cladorrhizans *Schp.*
Climacium americanum *Brid.*
Hypnum delicatulum *L.*
H. rusciforme *Weis.*
H. pulchellum *Dicks.*
H. reptile *Mx.*
H. imponens *Hedw.*
H. haldanianum *Grev.*
H. eugyrium *Schp.*
H. brevirostre *Ehrh.*
H. triquetrum *L.*
H. radicale *Bv.*
Cetraria islandica (*L.*) *Ach.*
Mitrula phalloides (*Bull.*) *Chev.*

Mrs M. A. Knickerbocker, Douglaston

Centaurea jacea *L.* | Galium verum *L.*

Miss Emma S. Thomas, Schoharie

Lepiota acutesquamosa *Weinm.* | Lycoperdon pyriforme *Schaeff.*

Miss Harriet A. Edwards, Port Henry

Botrychium virginianum (*L.*) *Sw.*

Mrs G. M. Dallas, Philadelphia Pa.

Thelephora caespitulans *Schw.*

Mrs T. B. Bishop, San Francisco Cal.

Xerophyllum tenax *Nutt.*

Miss M. L. Overacker, Syracuse

Podophyllum peltatum *L.*
Viola striata *Ait.*
Crepis virens *L.*
Lythrum salicaria *L.*
Stropharia aeruginosa (*Curt.*)

Miss N. L. Marshall, New York

Volvaria hypopithys *Fr.*

E. A. Burt, Middlebury Vt.

Poria subtilis (*Schrad.*) *Bres.*
Corticium sulphureum *Pers.*
Peniophora parasitica *Burt*
Asterostroma bicolor *E. & E.*
Dacryomyces deliquescens (*Bull.*) *Dub.*
Grandinia granulosa *Fr.*

M. L. Fernald, Cambridge Mass.

Carex atlantica *Bailey* | Carex elachycarpa *Fern.*

B. D. Gilbert, Clayville

Botrychium dissectum *Spreng.* | Lycopodium tristachyum *Pursh*

C. G. Lloyd, Cincinnati O.

Calostoma cinnabarinum *Desv.*
Geaster coliformis (*Dicks.*) *Pers.*
Lycoperdon glabellum *Pk.*

G. B. Fessenden, Boston Mass.

Pluteolus coprophilus *Pk.*

F. C. Stewart, Geneva

Colletotrichum antirrhini *Stewart*
C. rudbeckiae *Pk.*
Marsonia pyriformis (*Riess*) *Sacc.*

S. H. Burnham, Vaughns

Hepatica acuta (*Pursh*) *Britton*

E. B. Sterling, Trenton N. J.

Phallogaster saccatus *Morg.* | Morchella angusticeps *Pk.*

J. J. Hastings, Albany

Clitocybe multiceps *Pk.*
Pholiota praecox *Pers.*
Hypholoma incertum *Pk.*

E. B. Conger, Peninsula O.

Erythronium albidum *Nutt.*

H. L. Clapp, Roxbury Mass.

Hygrophorus ventricosus *B. & Br.*

J. B. Ellis, Newfield N. J.

Phyllosticta limitata fructigena *Ellis*

F. S. Boughton, Pittsford

Polyporus morgani *Frost*
Lycoperdon frostii *Pk.*
Fistulina pallida *B. & R.*

A. P. Hitchcock, New Lebanon

Boletus felleus *Bull.*

Rev. J. M. Bates, Callaway Neb.

Tylostoma campestre *Morg.*
T. poculatum *White*
Catastoma subterraneum *Pk.*
Geaster campestris *Morg.*

Simon Davis, Boston Mass.

Armillaria nardosmia *Ellis*
Hygrophorus sordidus *Pk.*
H. pallidus *Pk.*
Russula ventricosipes *Pk.*
Rhizopogon rubescens *Tul.*
Scleroderma verrucosum *(Bull.) Pers.*

W. F. Badè, Bethlehem Pa.

Anychia dichotoma *Mx.*

C. S. Banks, Manila, Philippine islands

Aquilegia canadensis *L.*
Trifolium repens *L.*
Potentilla canadensis *L.*
Geum rivale *L.*
Hamamelis virginiana *L.*
Zizia aurea *(L.) Koch*
Rumex acetosella *L.*
Cypripedium hirsutum *Mill.*
Asarum canadense *L.*
Eriophorum polystachyon *L.*
Carex sterilis *Willd.*
Onoclea sensibilis *L.*
Adiantum pedatum *L.*
Asplenium platyneuron *L.*
Dryopteris acrostichoides *(Mx.)*

F. J. Braendle, Washington D. C.

Polyporus lacteus *Fr.*
Clavaria grandis *Pk.*

J. V. Haberer, Utica

Ranunculus bulbosus *L.*
Trollius laxus *Salisb.*
Arabis hirsuta *(L.) Scop.*
A. laevigata *(Muhl.) Poir.*
Conringia orientalis *(L.) Dumort.*
Dentaria laciniata *Muhl.*
D. maxima *Nutt.*
Vaccaria vaccaria *(L.) Britton*
Geum vernum *T. & G.*
Opulaster opulifolius *(L.) Kuntze*
Polygala viridescens *L.*
Floerkea proserpinacoides *Willd.*
Sarothra gentianoides *L.*
Galium mollugo *L.*
Valerianella chenopodifolia *(Pursh) DC.*
Vernonia gigantea *(Walt.)*
Hieracium praealtum *Vill.*

Rhododendron maximum *L.*
Lysimachia quadrifolia *L.*
Tetragonanthus deflexus (*Sm.*) *Kuntze*
Monarda fistulosa *L.*
Hedeoma hispida *Pursh*
Koellia virginiana (*L.*) *MacM.*
Pentstemon pentstemon (*L.*) *Britton*
Dianthera americana *L.*
Scirpus sylvaticus *L.*
S. rubrotinctus *Fern.*
Eriophorum virg. album *Gray*
Rhynchospora glomerata (*L.*) *Vahl*
Hemicarpha micrantha (*Vahl*) *Britton*
Fimbristylis autumnalis (*L.*) *R. & S.*
Eleocharis diandra *Wright*
E. vigens (*Bailey*)
Botrychium lanceolatum *Angst.*
B. matricariaefolium *A. Br.*
B. obliquum *Muhl.*
B. tern. intermedium *Eaton*
Equisetum lit. gracile *Milde*
Lycopodium inundatum *L.*

H. H. Hume, Lake City Fla.

Exobasidium peckii *Halst.*
Entomosporium maculatum *Lev.*
Pyricularia grisea (*Cke.*) *Sacc.*
Sorosporium everhartii *E. & G.*
Puccinia graminis *Pers.*
P. fuirenae *Cke.*
P. hydrocotyles (*Mont.*) *Cke.*
P. hieracii (*Schum.*) *Mart.*
Ravenelia glanduliformis *B. & C.*
Uromyces elegans (*B. & C.*) *Lagh.*
U. caladii (*Schw.*) *Farl.*
U. spermacoces (*Schw.*) *Thum.*
U. graminicola *Burrill*
U. hedysari paniculati (*Schw.*)
Ustilago floridana *E. & E.*
Caeoma nitens *Schw.*
Scolecotrichum caricae *E. & E.*
Thecapsora vacciniorum *B. & C.*
Phyllosticta nerii *West.*
P. roberti *B. & J.*
P. phaseolina *Sacc.*
P. ipomaeae *E. & K.*
P. phomiformis *Sacc.*
P. vaccinii *Earle*
P. caryae *Pk.*
P. curtisii (*Sacc.*) *E. & E.*
P. livida *E. & E.*
P. acericola *C. & E.*
Pestalozzia palmarum *Cke.*
P. crataegi *E. & E.*
Septoria oenotherae *West.*
S. lycopersici *Speg.*
S. drummondii *E. & E.*
Graphiola phoenicis (*Moug.*) *Poit.*
Macrosporium asimini *Hume*
M. solani *E. & M.*
Helminthosporium ravenelii *B. & C.*
Peronospora gonolobii *Lagh.*
Plasmopara cubensis (*B. & C.*) *Hume*
Cystopus candidus (*Pers.*) *Lev.*
C. ipomaeae-panduratae (*Schw.*)
Exoascus varius *Atk.*
Cercospora petersii (*B. & C.*) *Atk.*
C. flagellaris *E. & M.*
C. hamamelidis *E. & E.*
C. phyllitidis *Hume*
C. hibisci *T. & E.*
C. vignae *E. & E.*
C. callicarpae *Cke.*
C. hydrocotyles *E. & E.*
C. ricinella *S. & B.*
C. apii *Fres.*
C. beticola *Sacc.*
C. catalpae *Wint.*
Sphaerostilbe coccophila *Tul.*
Meliola palmicola *Wint.*
Asterina inquinans *E. & E.*
Taphrina caerulescens (*D. & M.*)
Phyllactinia suffulta (*Reb.*) *Sacc.*
Uncinula clintonii *Pk.*
Microsphaera quercina (*Schw.*) *Burr.*
M. calocladophora *Atk.*
Sphaeria andropogicola *Schw.*
Rhytisma vaccinii *Earle*
Linospora ferruginea *E. & M.*
Phyllachora cyperi *Rehm.*
Phleospora mori *Sacc.*

Mrs Carolyn W. Harris, Brooklyn

Usnea barbata (*L.*) *Fr.*
U. barb. florida *Fr.*
U. barb. rubiginosa *Mx.*
U. longissima *Ach.*
Alectoria jub. chalybeiformis *Ach.*
Ramalina calic. fastigiata *Fr.*
R. calic. farinacea *Schaer.*
Evernia prunastri (*L.*) *Ach.*
Cetraria ciliaris *Ach.*
C. lacunosa *Ach.*
C. aurescens *Tuckm.*
Sticta pulmonaria (*L.*) *Ach.*
S. amplissima (*Scop.*) *Mass.*
Peltigera aphthosa (*L.*) *Hoffm.*
P. canina (*L.*) *Hoffm.*
P. polydactyla (*Neck.*) *Hoffm.*
P. rufescens (*Neck.*) *Hoffm.*
P. pulverulenta (*Tayl.*) *Nyl.*
Umbilicaria dillenii *Tuckm.*
U. vellea (*L.*) *Nyl.*
U. muhlenbergii (*Ach.*) *Tuckm.*
U. pustulata (*L.*) *Hoffm.*
Pyxine sorediata *Fr.*
Solorina saccata (*L.*) *Nyl.*
Parmelia perlata (*L.*) *Ach.*
Parmelia saxatilis (*L.*) *Fr.*
P. sax. sulcata *Nyl.*
P. sax. panniformis (*Ach.*)
P. caperata (*L.*) *Ach.*
P. conspersa (*Ehrh.*) *Ach.*
P. borreri *Turn.*
P. physodes (*L.*) *Ach.*
P. tiliacea (*Hoffm.*) *Fl.*
Physcia stellaris (*L.*) *Tuckm.*
P. aquila (*Ach.*) *Nyl.*
Theloschistes polycarpus (*Ehrh.*) *Tuckm.*
Pannaria lanuginosa (*Ach.*)
P. leucosticta *Tuckm.*
Leptogium pulchellum (*Ach.*) *Nyl.*
L. lacerum (*Sw.*) *Fr.*
L. tremelloides (*L.*) *Fr.*
Collema flaccidum *Ach.*
Stereocaulon paschale (*L.*) *Fr.*
Cladonia squamosa *Hoffm.*
C. furc. racemosa *Fl.*
Endocarpon fluviatile *DC.*
E. min. complicatum *Schaer.*
E. min. aquaticum *Schaer.*

Mrs E. Watrous, New York

Cortinarius violaceo-cinereus (*Pers.*) *Fr.*

Mrs E. C. Anthony, Gouverneur

Uredo polypodii (*Pers.*) *DC.*

M. S. Baxter, Rochester

Graphiola phoenicis (*Moug.*) *Poit.*

George E. Morris, Waltham Mass.

Tricholoma peckii *Howe*
Mycena strobilinoidea *Pk.*
Hygrophorus pudorinus *Fr.*
Cortinarius sanguineus (*Wulf.*) *Fr.*
Boletus parasiticus *Bull.*
Mutinus ravenelii (*B. & C.*) *Fisch.*
Calvatia elata (*Mass.*) *Morg.*
Hypoxylon howeanum *Pk.*
Cordyceps capitata (*Holmsk.*) *Lk.*
Cordyceps ophioglossoides (*Ehrh.*) *Lk.*
Helvella crispa (*Scop.*) *Fr.*
H. ephippium *Lev.*
H. macropus brevis *Pk.*
Geoglossum farlowi *Cke.*
G. peckianum *Cke.*
Bulgaria rufa *Schw.*

SPECIES NOT BEFORE REPORTED

C

Thalictrum occidentale Gray

Shore of Lake Champlain near Port Henry. The leaves of this plant bear some resemblance to those of Thalictrum dioicum, but in stature and time of flowering it suggests T. purpurascens to which it was doubtfully referred in a former report.

Conringia orientalis (L.) Dumort.

Along the N. Y. C. railroad near Utica. J. V. Haberer. This is an introduced plant having a tendency in some places to become a troublesome weed.

Sophia sophia (L.) Britton

Thin soil in rocky places. About the ruins of the old fort on Crown Point. May. This is Sisymbrium sophia L.

Geum vernum T. & G.

Mohawk flats. Deerfield, Oneida co. Abundant in a meadow near a little lake on the north side of Mohawk river about a mile below Utica. It may have been introduced from the west. It is distinguished from closely related species by its stalked receptacle. June. J. V. Haberer.

Crataegus champlainensis Sarg.

Crown Point and near North Albany. May and June. The species of Crataegus have recently been made the subject of special investigation by some of the botanists in this country. The result has been the recognition of many species previously overlooked or confused with other known forms. Good specific characters have been found in parts of the plant formerly disregarded or considered unreliable in the identification of species.

Crataegus pringlei Sarg.

Crown Point and near North Albany. May and June. This species may be recognized by the peculiar habit of its foliage.

The mature leaves, by the deflection of their margins, have a drooping appearance, the upper surface being convex, the lower concave. This is shown to some extent in the dried specimens in the herbarium. The leaves do not flatten fully in the plant press but present folds or wrinkles when dried.

Crataegus modesta Sarg.

Dry hills and slaty knolls. Near North Albany and Lansingburg. June. The specimens which we have referred to this species meet the description fairly well but the plant is quite variable. On dry clayey hillocks north of Albany it has a straggling starved appearance, bears small leaves and few or no thorns. On slaty knolls north of Lansingburg it is more thrifty, has larger leaves which are often somewhat three lobed by reason of the greater development of the basal lobes, and it bears more numerous thorns which are sometimes 2 inches long. It flowers a little later than the two preceding species and is also later in ripening its fruit. It is a rather small shrub, usually 4 to 6 feet high.

Crataegus holmesiana Ashe

Near North Albany and Lansingburg, also in Sandlake where it is the prevailing species. May. The number of stamens varies from 5 to 8, and serves when the plant is in blossom as a distinctive mark of the species. The fruit ripens early in September and has an agreeable flavor.

Crataegus pruinosa Wend.

Crown Point, North Albany and Lansingburg. The pruinosity of the fully grown fruit is a convenient mark for the recognition of this species.

Vernonia gigantea (Walt.) Britton

Stony, hilly pastures. New Hartford, Oneida co. September. J. V. Haberer.

Antennaria parlinii arnoglossa Fern.

Pastures. Crown Point. May.

Centaurea jacea L.

Douglaston, Queens co. August. Mrs M. A. Knickerbocker. It has also been reported from Deerfield by Dr Haberer but I have seen no specimens from that locality. The plant is sometimes cultivated for ornament and has escaped from cultivation.

Arctium minus Schk.

Near Loon lake station. July. This was formerly considered a variety of A. lappa.

Lactuca morssii Robins.

Clearings and waste places. North Elba and Loon lake station. July. In general appearance this species resembles L. canadensis and L. leucophaea. From the former it may be distinguished by its purplish or violet colored flowers and the shorter beaked achenia, from the latter by its snowy white pappus.

Hedeoma hispida Pursh

Thin naked soil covering rocks. Little Falls. June. Probably introduced from the west. J. V. Haberer.

Panicularia laxa Scribn.

Margin of a pond near Loon lake station. July. The specimens have the small few-flowered spikelets of this species but the upper sheaths do not overlap as in the typical form.

Mylia anomala (Hook.) S. F. Gray

Marshes. West Fort Ann. November. S. H. Burnham.

Scapania irrigua (Nees) Dumort.

Marshes. West Fort Ann. October. S. H. Burnham.

Stereocaulon denudatum Fl.

Bare rocks. Mt Marcy, Mt McIntyre and Mt Wallface. July. All the specimens are sterile.

Endocarpon fluviatile DC.

Near Chilson lake. June. Mrs C. W. Harris.

Cetraria aurescens Tuckm.

Bark of pine, Pinus strobus. Near Chilson lake. June. Mrs C. W. Harris.

Pannaria leucosticta Tuckm.

Granitic rocks. Near Chilson lake. July. Mrs Harris.

Lepiota adnatifolia n. sp.

Pileus thin except in the center, broadly convex or nearly plane, minutely granulose or squamulose, isabelline, alutaceous or reddish ferruginous, the margin usually appendiculate with fragments of the veil, flesh white; lamellae thin, moderately close, adnate, white; stem short, generally slightly thickened at the base, solid when young but sometimes becoming stuffed or hollow with age, glabrous or slightly squamulose below the small often evanescent ring, pallid or subrufescent; spores minute, .0002–.00024 of an inch long, .00016–.0002 broad.

Pileus 1–2.5 inches broad; stem 1–1.5 inches long, 2–4 lines thick. Ground under pine trees. Bolton and Hague, Warren co. September.

The color ornamentation and size are nearly the same as in L. granulosa, from which it differs in its slight veil, larger spores and specially in its adnate lamellae. By this character some species of Lepiota show an affinity with the genus Armillaria. Our four species having this character may be indicated by the subjoined synoptic table.

	Plant growing on the ground	1
	Plant growing on decaying wood	L. granosa
1	Plant having a disagreeable odor	L. rugosoreticulata
1	Plant inodorous	2
2	Stem 1–2 lines thick, pileus generally umbonate	L. amianthina
2	Stem 2–4 lines thick, pileus not umbonate.	L. adnatifolia

Tricholoma rimosum n. sp.

Pileus fleshy, convex becoming nearly plane, often split on the margin, glabrous, hygrophanous, watery brown and shining

when moist, paler when dry, flesh colored like the pileus when moist, whitish when dry, taste farinaceous; lamellae thin, narrow, very close, rounded behind, adnexed, uneven on the edge, whitish or subcinereous; stem nearly equal, silky-fibrillose, hollow, whitish; spores elliptic, .0003–.00035 of an inch long, .00016–.0002 broad.

Pileus 1–1.5 inches broad; stem 1–2 inches long, 1.5–2.5 lines thick. Woods. Bolton. September.

This species is related to T. h u m i l e from which it may be distinguished by its smaller size, hollow silky fibrillose stem, the rimose margin of the pileus and its farinaceous taste.

Clitocybe regularis n. sp.

PLATE K, FIG. 1–7

Pileus thin, flexible, broadly convex becoming nearly plane, often slightly depressed in the center, orbicular, regular, whitish when moist, white when dry, flesh white, taste mild; lamellae thin, narrow, crowded, decurrent, whitish; stem firm, equal, glabrous, solid, rarely with a very small cavity, whitish, spongy thickened at the base; spores minute, .0002 of an inch long, .0001–.00012 broad.

Pileus 1–2.5 inches broad; stem about 1 inch long, 1.5–2.5 lines thick.. Among fallen leaves in woods. Bolton. August.

This species is related to C. t o r n a t a, from which it differs in its thin flexible moist pileus, its distinctly decurrent lamellae and in its solid stem with the spongy mass of mycelioid tomentum at the base.

Clitocybe subconcava n. sp.

PLATE K, FIG. 8–13

Pileus thin, convex, deeply umbilicate, glabrous, hygrophanous, brownish or reddish brown and usually striatulate on the decurved margin when moist, whitish when dry; lamellae arcuate, decurrent, close, pallid or subcinereous; stem equal, firm, solid or stuffed, sometimes with a small cavity, slightly fibrillose, colored like the pileus; spores minute, .0002–.00024 of an inch long, .00012–.00016 broad.

Pileus 1–2 inches broad; stem 1–2 inches long, 1.5–2 lines thick. Pine woods. Bolton. August.

Closely related to C. concava from which it may be separated by its much smaller spores and paler color. The decurved margin of the pileus is even, not wavy as in that species. It is also allied to C. cyathiformis and C. expallens, from both of which its smaller spores and deeply umbilicate pileus separate it. It is without any distinctive odor.

Pleurotus minutus n. sp.

Pileus minute, reniform or suborbicular, at first resupinate, sometimes becoming reflexed with age, often slightly depressed in the center; flocculose pruinose, white, the margin involute; lamellae unequal, very narrow, distant, decurrent, white or whitish; stem short, eccentric, curved, pruinose, whitish with a white mycelioid tomentum at the base.

Pileus 1–2 lines broad; stem about 1 line long. Much decayed wood of birch. Near Loon lake. July.

The very small size, narrow distant decurrent lamellae and pruinose pileus and stem are the prominent characters of this minute species. The specimens are sterile.

Lactarius foetidus n. sp.

Pileus fleshy, firm, nearly plane or centrally depressed, minutely downy or velvety, pale yellow or buff, becoming brownish where bruised, flesh whitish, milk white, taste mild, odor fetid; lamellae subdistant, adnate or slightly decurrent, yellowish white, becoming reddish brown where wounded or bruised; stem short, equal, solid, glabrous, whitish; spores broadly elliptic or subglobose, .00024–.00032 of an inch long, nearly as broad.

Pileus 2–3 inches broad; stem 1–2 inches long, 4–6 lines thick. Low damp ground in woods. Snyders, Rensselaer co. August.

The fetid disagreeable odor and buff color of the pileus are distinguishing characters of this rare species. The downy surface of the dry pileus is soft to the touch, like that of L. vellereus.

Hygrophorus glutinosus n. sp.

Pileus fleshy, firm, convex, glutinous, white, sometimes tinged with yellow by the drying of the gluten, the margin involute, flesh white; lamellae subdistant, adnate, white; stem equal, solid, white, floccose tomentose and glutinous below the glutinous annulus, studded above with glandular drops of moisture which in drying form reddish dots; spores .0003–.0004 of an inch long, .0002–.00024 broad.

Pileus 1–2 inches broad; stem about 1 inch long, 3–4 lines thick.

In the fresh plant the lower part of the stem appears to be coated with a floccose tomentum smeared with gluten, in the dried plant the gluten assumes an orange yellow or bright straw color and the tomentum disappears. The species differs from H. gliocyclus in its adnate lamellae and from H. eburneus in its solid stem with reddish points at the top.

Volvaria speciosa Fr.

Westfield, Chautauqua co. June. E. B. Sterling.

Volvaria hypopithys Fr.

Lake Placid. September. Miss N. L. Marshall.

Cortinarius submarginalis n. sp.

PLATE L, FIG. 6–10

Pileus fleshy, firm, convex becoming nearly plane, or concave by the elevation of the margin, viscid when moist, yellowish brown, generally a little paler on the rather definite and commonly fibrillose margin, flesh whitish; lamellae thin, close, adnate, creamy yellow when young, soon cinnamon; stem rather long, equal or slightly thickened at the base, solid, silky fibrillose, slightly viscid, whitish or pallid; spores subelliptic, .0004–.0005 of an inch long, .0002–.00024 broad.

Pileus 2–4 inches broad; stem 3–6 inches long, 4–6 lines thick.

Low moist places in woods. Bolton. August.

The margin of the pileus is generally paler than the rest and separated from it by a definite line. It is from 3–6 lines broad

and is sometimes curved upward and conspicuously fibrillose. This difference between the margin and the rest of the pileus is not clearly shown in the dried specimens. The species belongs in the section Myxacium.

Cortinarius obliquus n. sp.

PLATE L, FIG. 1–5

Pileus rather thin, broadly convex or nearly plane, dry, silky fibrillose, white or grayish, generally with a slight violaceous tint, flesh whitish; lamellae thin, close, adnate or slightly rounded behind, minutely crenulate on the edge and obscurely transversely striate on the sides, deep violet becoming cinnamon brown with age; stem equal, solid, shining, silky fibrillose, whitish tinged with violet, violet within, with an abrupt flattened oblique bulb at the base; spores elliptic, uninucleate, .0003 of an inch long, .0002 broad.

Pileus 2–3 inches broad; stem 2–3 inches long, 3–5 lines thick. Among fallen leaves in woods. Bolton. August.

This species is well marked by the white or grayish white pileus, the deep violet or almost amethystine color of the young lamellae and the oblique flattened bulb of the stem. It belongs to the section Inoloma. C. albidus Pk. has an oblique bulb at the base of the stem and a white pileus but it belongs to the section Phlegmacium as its pileus is viscid. Its young lamellae are also white.

Cortinarius violaceo-cinereus (Pers.) Fr.

Pine woods. Hague, Warren co. June. Mrs E. Watrous. A large cespitose form. A scattered or gregarious form occurs in woods near Bolton. September. In *Systema mycologicum* and in *Epicrisis*, Fries gives C. violaceo-cinereus as the name of the species, but in *Hymenomycetes Europaei* he changed the form of the name to C. cinereo-violaceus without giving any reason for the change. This name has been adopted in *Sylloge*, but we have retained the older form.

Boletus multipunctus n. sp.

PLATE K, FIG. 19–22

Pileus fleshy, convex or nearly plane, dry, brownish ocher, sometimes with a slight reddish tint, the central part adorned with many minute slightly darker areolate spots or dots, flesh whitish, taste mild; tubes small, adnate or depressed about the stem, ventricose in the mass, the mouths subrotund, at first whitish, becoming greenish yellow; stem equal or tapering upward, pallid, solid, fibrous striate; spores dark olive green, oblong, .00045–.0006 of an inch long, .00016–.0002 broad.

Pileus 3–5 inches broad; stem 3–5 inches long, 4–8 lines thick.

In woods. Bolton. August.

The species belongs to the section Edules. It was not found in sufficient quantity for testing its edibility but it is probably edible.

Fistulina pallida B. & R.

Pittsford, Monroe co. July. F. S. Boughton. These specimens correspond to the description of F. pallida except in their larger size. They are distinct from F. firma Pk. in their darker color and decurrent tubes.

Poria myceliosa n. sp.

Subiculum membranaceous, separable from the matrix, connected with white branching strands of mycelium which permeate the soft decayed wood, or with radiating ribs which run through the broad sterile fimbriate white margin; pores very short, subrotund angular or subflexuous, the dissepiments thin, acute, dentate or slightly lacerate, pale yellow; spores minute, subglobose, .00008–.00012 of an inch broad. Round Lake, Saratoga co. August.

This fungus forms patches several inches in extent on much decayed wood of hemlock. It follows the inequalities of the surface on which it grows. It is scarcely more than half a line thick. The pores develop from the center toward the margin and at first are mere concavities in the subiculum. The species is apparently related to P. tenuis Schw., from which it

differs in habitat, color and the prominent mycelial strands. In this last character it bears some resemblance to P. vaillantii (DC.) Fr.

Hydnum umbilicatum n. sp.

PLATE K, FIG. 14–18

Pileus fleshy, convex, glabrous, umbilicate, reddish buff or burnt sienna color, flesh white, taste mild; aculei plane in the mass, fragile, nearly equal, a little paler than the pileus; stem nearly equal, glabrous, solid, whitish; spores globose, .0003–.0004 of an inch in diameter.

Pileus 6–18 lines broad; stem 1–1.5 inches long, 2–4 lines thick. Among fallen leaves in woods. Hague. September.

This species is related to H. repandum and H. rufescens, from both of which it is easily separated by its small but usually deep and distinct umbilicus. Sometimes a definite line separates the paler margin from the more highly colored center of the pileus. In the last report it was mentioned as a form of H. rufescens.

Thelephora multipartita Schw.

Grassy ground under trees. Bolton. August. This species is variable in size, in the number of divisions of the pileus and consequently in its general appearance. It is related to T. anthocephala and T. caryophyllea, but the upper surface of the pileus or of its component parts is usually paler than in these species.

Thelephora exigua n. sp.

Pileus very thin, submembranaceous, tubaeform or infundibuliform, faintly radiately fibrous striate, slightly lacerate on the margin, pale alutaceous; hymenium even or faintly striate, pruinosely pubescent, pallid; stem slender, solid, pruinosely pubescent, brownish; spores elliptic, .00016 of an inch long, about half as broad.

Pileus 1.5–3 lines broad; stem 2–3 lines long. Vegetable mold. Westport, Essex co. October.

This minute species may be separated from T. ravenelii Berk. and T. regularis Schw. by its smaller size and by the minute pubescence of its hymenium and stem.

Corticium portentosum B. & C.

Decorticated wood of spruce. North Elba. July.

Corticium arachnoideum Berk.

Decorticated wood of pine. Bolton. September.

Peniophora affinis Burt *in litt.*

Bark of dogwood, Cornus florida. East Schodack. August. Closely allied to P. laevis (Fr.) Burt.

Peniophora parasitica Burt *in litt.*

Under side of branches of juniper, Juniperus communis, lying on the ground. Hague. September.

Asterostroma bicolor E. & E.

Decaying wood of spruce. Floodwood, Franklin co. August. E. A. Burt.

Sebacina calcea (Pers.) Bres.

Under side of dead spruce branches. Hague. September.

Clavaria bicolor n. sp.

Small, 8–12 lines high, gregarious; stem slender, .5–1 line thick, straight or flexuous, solid, tomentose, pale yellow, divided above into two or more short, orange colored compressed branches which are themselves once or twice dichotomously divided, tips acute, concolorous.

Under pine trees. Bolton. September.

The rather tough tomentose stem indicates an affinity to the genus Lachnocladium.

Phallogaster saccatus Morg.

Decaying wood. Westfield, Chautauqua co. June. E. B. Sterling.

Cyathus lesueurii Tul.

Lyndonville, Orleans co. C. E. Fairman. Also in Bethlehem, Albany co. In our specimens there are small cavities in the

interior of the peridium near its base in each of which a sporangiole rests. The funiculus is short, but when moist it can be stretched to a great length. This species may be distinguished from C. vernicosus by the less spreading margin of the open peridium and by its much larger spores.

Craterium minimum B. & C.

Dead sticks and leaves. West Albany. C. cylindricum Massee is a synonym.

Craterium minutum (Leers) Fr.

On mosses. East Berne, Albany co. August.

Didymium fairmani Sacc.

On foliage of two leaved Solomon's seal, Unifolium canadense. Ridgeway, Orleans co. C. E. Fairman. Closely allied to D. melanospermum, from which it differs in its rather smaller peridium and spores. The typical form is sessile, but specimens sometimes occur with a short slender stem.

Physarella multiplicata Macb. *in litt.*

Spreading over ground and living plants. Menands, Albany co. June. The white plasmodium spreads over anything in its way and the mature fungus develops from it in 24 hours in very warm weather.

Empusa grylli Fresen.

It attacks and kills grasshoppers. Surfaces on which the dead bodies of the grasshoppers rest become whitened by the pyriform conidia of the fungus shed from the bodies of the insects.

Marsonia pyriformis (Riess) Sacc.

Upper surface of leaves of silver poplar, Populus alba. Penn Yan. September. F. C. Stewart.

Septoria polygonina Thum.

Living leaves of the fringed black bindweed, Polygonum cilinode. Near Loon lake. July. In our specimens the

spots on the leaves have not the violaceous margin attributed to the typical form of the species and they are generally marked by a few elevated lines or ridges. Their color is usually reddish brown rather than ochroleucous. The difference in the host plants is probably the cause of the difference in the spots.

Chalara paradoxa (Seynes) Sacc.

Decaying pineapple. Menands. June. The inner flesh of the affected fruit is blackened by the fungus.

Colletotrichum antirrhini Stewart

Living stems and leaves of great snapdragon, Antirrhinum majus. Geneva. September. F. C. Stewart.

Colletotrichum rudbeckiae n. sp.

Pustules minute, numerous, closely gregarious, round or hysteriiform, black, at first covered by the epidermis, then erumpent; setae few, black; spores straight or slightly curved, acute, hyaline, .0005–.0006 of an inch long, .00016 broad. Dead stems of cultivated cone flower, Rudbeckia laciniata. Geneva. July. F. C. Stewart.

Helvella adhaerens n. sp.

PLATE L, FIG. 11–15

Pileus thin, irregular, deflexed, whitish or smoky white, becoming brownish with age or in drying, the lower margin attached to the stem, even and whitish beneath; stem slender, even, solid, pruinosely downy, smoky white or brownish, the upper part concealed by the deflexed pileus and smaller than the lower exposed part; asci cylindric, 8 spored; spores elliptic, often uninucleate, .0007–.0008 of an inch long, .0005 broad; paraphyses filiform, hyaline, thickened or subclavate at the top.

Ground in woods. Bolton and Hague. August and September. Related to H. elastica, from which it is easily distinguished by having the deflexed margin of the pileus attached to the stem. When young and fresh the whole plant is whitish or dingy white, but it is apt to become brownish with age or in drying.

Lachnella corticalis (Pers.) Fr.

Dry naked bark or among mosses on the base of living aspens, Populus tremuloides. North Elba. July.

Orbilia luteo-rubella (Nyl.) Karst.

Damp decaying wood, specially of deciduous trees. North Elba. July. A common species, usually becoming more highly colored in drying.

Anthostoma dryophilum (Curr.) Sacc.

Dead branches of chestnut. Lyndonville, Orleans co. C. E. Fairman.

Mycenastrum spinulosum Pk.

Grassy ground about the ruins of the old fort on Crown Point. September. Three young specimens and two fragments of an old specimen were found. This material is scarcely sufficient for a satisfactory identification of the species, but the peculiar threads of the capillitium and the character of the spores indicate this species. The locality, however, is very distant from that of the original specimens. It is desirable that mature specimens in good condition may yet be found.

D

REMARKS AND OBSERVATIONS

Hepatica acuta (Pursh) Britton

Vaughns, Washington co. April. S. H. Burnham. The specimens represent a variety in which each of the three lobes of the leaf is itself three lobed.

Castalia tuberosa (Paine) Greene

Abundant in the sloughs and still waters about Fort Ann, Washington co. In deep water the leaves float on the surface, but in shallow water they stand erect above the surface, supported by their stout firm petioles.

Draba incana arabisans (Mx.) Wats.

Precipices of Mt Wallface. This is the only locality in the state, so far as known to me, where this plant is found. It flowers in June or early in July. Specimens collected July 19 were past flowering.

Meibomia paniculata (L.) Kuntze

In rocky places at Bolton a form occurs in which the midrib and, to some extent, the principal veins are bordered by a pale stripe.

Viburnum pauciflorum Pylaie

In our state this species is apparently limited to the Adirondack region and is scarce even there. It occurs sparingly along some of the cool shaded streams that flow down the steep rocky sides of Mt Marcy, Mt McIntyre and Mt Clinton. It is in flower in the latter part of June, but the fruit is not ripe before August.

Ludwigia alternifolia L.

Abundant in a swampy place about a mile west of Menands. The persistent colored foliaceous lobes of the calyx give it the appearance of being in flower late in the season, even when its fruit is mature.

Chamaenerion angustifolium (L.) Scop.

A pale flowered form occurs near Loon lake. It is intermediate between the common form and the white flowered form.

Galinsoga parviflora hispida DC.

Waste places. Bolton. August. Escaped from cultivation. More hairy or hispid than the common form and having the pappus narrowed above into a bristle. The upper part of the branches and specially the peduncles are glandular hairy in our specimens. These characters and the coarsely toothed margin of the thicker leaves give the plant a peculiar appearance and would seem to make it worthy of specific distinction.

Rudbeckia triloba L.

East Schodack, Rensselaer co. August. Neither the *Manual* nor the *Illustrated flora* credits this species to New York, but it has been found growing wild in Dutchess and Ulster counties. The station in Rensselaer co. is the most northern one in which I have found it.

Gaylussacia resinosa glaucocarpa Robinson

Fort Ann, Washington co. and Glen lake, Warren co. August. S. H. Burnham.

Euphorbia platyphylla L.

Rare. On the east shore of Bulwagga bay southeast of Port Henry. September.

Betula papyracea minor Tuckm.

Plentiful and fertile on the open summit of Mt Clinton.

Juniperus communis alpina Gaud.

The alpine juniper is more abundant on Mt Clinton than on the higher summit of its near neighbor, Mt McIntyre. It bears fruit sparingly here. The arbor vitae, Thuja occidentalis, ascends to the open summit of this mountain, but the trees are small and unthrifty.

Potamogeton lonchites Tuckm.

Small but fertile plants of this pond weed and of P. obtusifolius, occur in shallow water in a small pond near Loon lake station.

Juncoides spicatum (L.) Kuntze

The spiked wood rush was found growing on the top of Mt Wallface in 1898. This remained the only known station for it in our state till this year. In July fine fruiting specimens of it were found growing near the base of the cliffs on the western side of Indian pass near its southern end. In these specimens the lowest fruit cluster is 1 or 2 lines distant from the rest.

Eleocharis diandra Wright

This beautiful spike rush has generally been treated as a mere form of the ovoid spike rush, E. ovata, but a fine series of specimens collected on the shore of Oneida lake by Dr Haberer and contributed by him to the herbarium leads me to keep it distinct.

Scirpus peckii Britton

A station for this rare bulrush was discovered in July near Loon lake in Franklin co.

Scirpus rubrotinctus confertus Fern.

Swampy places near Loon lake. July. This variety was found growing with the typical form, which is not rare in the Adirondack region.

Scirpus atrocinctus brachypodus Fern.

Swampy or wet places. North Elba and near Loon lake. This bulrush also grows in company with the typical form and clearly passes into it by intergrading forms. July.

Homalocenchrus oryzoides (L.) Poll.

Low ground on the shore of Lake George at Hague. A form in which all the panicles are included in the leaf sheaths, except in occasional specimens in which the terminal panicle is exserted. September.

Agrostis alba L.

Specimens of this common and useful grass were collected near Loon lake. In them the glumes of nearly all the flowers of the panicle are elongated to three or four times their usual size. This gives the grass a singular appearance. These flowers are sterile. A similar form of A. alba vulgaris is already represented in the herbarium.

Poa flava L.

This grass usually grows in low wet ground or in marshy places, but a slender form with small two or three flowered spikelets scarcely more than 1 line long occurs in the Adirondack region growing on rocky ledges. Specimens were collected on the cliffs of Mt Wallface in July.

Equisetum littorale gracile Milde

Gravelly inundated shore of Oneida lake. June. J. V. Haberer.

Lycopodium annotinum L.

A slender form of this species is found in Indian pass, approaching variety pungens in character but having the leaves more distant and spreading. It is intermediate between the variety and the common form.

Lycopodium clavatum monostachyon Hook.

Rocky places. North Elba. July. Growing with the common form.

Woodsia obtusa angusta Pk.

Rocky places in the Highlands. Specimens of this variety were collected many years ago on Crow's Nest mountain between

Cornwall and West Point. In his *List of North American Pteridophytes*, Mr B. D. Gilbert, to whom specimens were sent, has recognized this variety and published a description of it under the name here given. This variety is represented on the sheet placed in the herbarium by Dr Torrey to illustrate the species, but no locality is recorded for it. The broader or common form is represented by specimens from Rensselaer and Warren counties.

Amanita phalloides striatula n. var.

Pileus thin, nearly plane, slightly striate on the margin, white; stem long, slender, slightly sheathed at the base by the remains of the ruptured volva. Bolton. August.

This amanita departs so distinctly from the character of A. phalloides in having the margin somewhat striate, that it would seem at first thought best to separate it as a distinct species, but that is such a variable species and this is so closely allied, differing only in the striate margin from small forms of A. phalloides verna, it seems best to regard it as a mere variety. The pileus is 1–2 inches broad and the stem 3–5 inches long and 2–3 lines thick, with a small bulb at the base. The annulus is well developed and the spores are globose and of the same size as in the typical form of the species.

Amanita muscaria formosa (G. & R.) Fr.

If we regard the beautiful amanita as a mere variety of the fly amanita it may be said to be the prevailing representative of the species in the eastern and northern parts of the state. It was very abundant the past season about Lake George. Its pileus is generally pale yellow or citrine color and its warts are also pale and easily removable. Sometimes specimens occur which are red or orange in the center of the pileus. It is apparently less poisonous than the true fly amanita, or else some persons are not easily affected by it. An instance was recently reported to me in which one person by mistake cooked and ate two caps of it without experiencing any ill results. This is the third person who has made a similar report to me.

Still the relationship is so close between this variety and the true fly amanita that I would not advise any one to experiment with it as food.

Tricholoma peckii Howe

This species agrees very closely with the description given by Fries of Armillaria aurantia, from which it scarcely differs except in the character of the ornamentation of the stem and in the absence of any semblance or form of an annulus. In our plant the scales of the stem are very small and not verrucose nor concentrically arranged as indicated by the Friesian description and figure of A. aurantia in *Icones Hymenomycetum*. Fries himself says that there is no distinct annulus present in A. aurantia, but the scales of the stem definitely and concentrically ceasing 2–3 lines from the top of the stem afford an annular zone. It seems strange that on such slight evidence as this he should place the species in the genus Armillaria while its alliance with the genus Tricholoma is much more strongly indicated by other characters. In our plant there is a slight downy pruinosity on the margin of the pileus in the young state, which is good evidence of its relationship to the genus Tricholoma, but it is possible that this character is not present in the European plant, for I find no mention made of it in the descriptions of A. aurantia. The viscid pileus and the change of color assumed by the lamellae with advancing age in our plant point so clearly to an intimate alliance with such species as T. flavobrunneum, T. albobrunneum, T. ustalis, and T. stans, that stronger evidence than any we have yet seen in it would be necessary to induce us to disregard this alliance and place it in Armillaria. It is perhaps worthy of note that while designating the European plant, which he considers the same as the Agaricus aurantius of Schaeffer, as an Armillaria, Fries, in the work already mentioned, has actually placed both the description and the figure of it among the descriptions and figures of species of the genus Tricholoma, and he himself says that the species is ambiguous between Armillaria and

Tricholoma. We do not think there is any ambiguity about the proper place for the American plant. Schaeffer describes his plant as having the pileus striate with filaments, and the stem also as striate with filaments, destitute of a veil but having a spurious annulus. His figure supports this description and also indicates the presence of concentrically arranged squamules on the stem. Gillet says that the plant has an incomplete annulus and his figure of the species, like that of Schaeffer, indicates one formed by the abrupt termination of the scaly surface of the stem. He also attributes a strong nauseous odor and an acrid and bitter taste to the plant, but says nothing of the farinaceous odor and taste which is so evident in our plant. These discrepancies between the European plant and the American lead us to keep our plant separate, though it may be only a variety.

Tricholoma fallax Pk.

In *Illustrations of British fungi* 8:1151 this species is figured with white lamellae. I have never seen the American plant with white lamellae, not even when young. They are yellow when young inclining to ochraceous as they become older. In the moist plant they are a little paler than the pileus, but when dry they have nearly the same color.

Collybia confluens campanulata n. var.

Pileus campanulate, 1–3 inches broad; lamellae and stem whitish or subcinereous. Growing in circles under pine trees. Bolton. September.

This variety is remarkable for the large size and persistently campanulate form of its pileus and for its habit of growing in clusters which stand in arcs of circles. The clusters are often so compact that the pilei are crowded and very irregular in consequence.

Another variety was found in small quantity near Bolton in August. In it the stem and lamellae are clear white. I would call it variety niveipes.

Omphalia campanella sparsa n. var.

Pileus convex, with a small umbilicus; lamellae yellow, decurrent, rather broad, subdistant, interspaces veiny; stem long, slender, equal, straight, glabrous, with a copious tawny tomentum at the base and sometimes a slight tawny mealiness at the top, hollow, black or brownish black.

Scattered or loosely gregarious. Among fallen leaves and sticks under pine trees. Bolton. August. Several varieties of this species have already been described but this corresponds to none of them. In its habitat and mode of growth it approaches varieties badipes and papillata, from the former of which it differs in the color and character of both pileus and stem, and from the latter in the shape of the pileus. The small umbilicus is not deep and it sometimes contains a small blackish papilla. The pileus is 4–6 lines broad and the stem 1–2 inches long but scarcely more than half a line thick.

Nyctalis asterophora Fr.

This fungus with us is nearly always affected by what seems to be a parasitic fungus which covers the pileus with a pulverulent coat of tawny brown or cervine stellate spores. This appears to prevent in some cases the development of the lamellae and consequently of its own spores. But the form having lamellae does sometimes occur. Such specimens were found near Bolton in August. When young the pileus is white and its margin involute. It has a farinaceous taste and odor. The stem also is at first white externally, but brown within. It is stuffed or hollow. The lamellae are rather distant and narrow. Such specimens sometimes become pulverulent and discolored after collection and before they can be dried.

Lentinus ursinus Fr.

This species varies beyond the limits assigned to it in the description. Specimens were found growing on an old prostrate birch trunk, Betula lutea, near Bolton, that were from 2–4 inches broad. When young the pileus is convex with an involute margin, glabrous and whitish, but with advancing

age a fuscous tomentum appears about the base and sometimes extends till it covers the whole surface. The flesh is rather thick, tough and flexible, and has a hot peppery taste. The edges of the lamellae are dentate rather than lacerate. Sometimes the pilei are clustered or imbricated.

Lenzites betulina radiata n. var.

Pileus thin, about 1 line thick, 1.5–3 inches broad, coriaceous, velvety hairy, narrowly multizonate, beautifully radiate striate, brown, substance white; lamellae unequal, occasionally forked, not anastomosing, smoky white or brownish. Dead trunks of beech. Hague. September.

The radiate striate appearance of the surface of the pileus is due to a linear arrangement of minute tufts of hairs radiating from the base to the margin. In the description of the species the lamellae are said to anastomose, but in this variety they do not, and in most American specimens that I have seen and that have been referred to this species, the lamellae are simple or occasionally branched. The species must be very variable if reliance is to be placed on the illustrations of it by European authors. Schaeffer's table 57 represents a thin nearly plane pale form with lamellae irregularly branched and slightly anastomosing, Berkeley's *Outlines* t. 15 f. 3 shows a thick triquetrous form with lamellae abundantly anastomosing, and Cooke's *Illustrations of British fungi* t. 1145 A indicates a thin brown zonate hairy pileus with white lamellae sparingly forked but not anastomosing. This corresponds well to our common American form except in the white color of the lamellae.

Hypholoma aggregatum sericeum n. var.

About old stumps in woods. North Bolton. September. This variety differs from the typical form of the species in its larger size and in having the pileus silky fibrillose and destitute of spots or scales. For a more full description see the part of this report devoted to edible fungi.

Boletus chrysenteron deformatus n. var.

Pileus small, scarcely more than an inch or an inch and a half broad, very irregular, brick red or tawny red; stem very short, often irregular, ventricose or tapering downward.

Bare earth on sloping banks by roadside. Bolton. August. The stem is but little longer than broad, and the pileus scarcely rises above the surface of the earth.

Cyclomyces greenii Berk.

In 1872 a single specimen of this rare fungus was found in Sterling, Cayuga co. A second specimen of it was found in September of the present year near Bolton, Warren co. This specimen is peculiar in having two stems but one pileus.

Mucronella minutissima conferta n. var.

Aculei very numerous, crowded and forming continuous patches. Otherwise as in the typical form. Decaying wood of birch, Betula lutea. Near Loon lake. July.

E

EDIBLE FUNGI

Tricholoma russula (Schaeff.) Fr.

REDDISH TRICHOLOMA

PLATE 77, FIG. 1–5

Pileus fleshy, firm, convex becoming nearly plane or sometimes concave above by the elevation of the margin, viscid when moist, often minutely squamulose spotted in the center, slightly floccose pruinose on the margin when young, pale pink or rosy red, flesh white, taste mild; lamellae thin, moderately close, slightly rounded behind, white usually becoming reddish spotted with age or where wounded; stem firm, solid, white, often with reddish stains toward the base; spores white, .00025–.0003 of an inch long, .00016 broad.

The reddish tricholoma is a pretty mushroom. Its cap with us is usually a pale pink or rosy red, though the European plant is sometimes figured with a much brighter color and the typical form is described by Schaeffer as pale purple. He also describes and figures his plant as having the cap finely punctate or dotted,

but I have seen no American specimens showing this character fully. The dots in our plant are generally limited to the central part of the surface of the cap, and sometimes they are wanting entirely in the young plant. The reddish color is similar to that seen in some species of Russula and is suggestive of the specific name of this mushroom. It may be distinguished from similarly colored species of the genus Russula by the downy pruinosity of the margin of the cap in the young plant, by the different texture of its flesh and the different shape of its spores. The color of the cap of the European plant is said to be varied sometimes with yellow spots but I have seen no such variation in the American plant. The cap being viscid when moist is often soiled by adhering particles of dirt, fragments of twigs or fallen leaves.

The gills are white but sometimes become spotted with reddish hues when old or bruised. They are slightly excavated or notched on the edge at the end next the stem. The stem is short in proportion to the size of the mushroom, solid, and commonly white, specially in the young plant, but when old it is often more or less varied with reddish stains. It is sometimes slightly adorned with flocculent particles or scales near the top.

The cap is 2–5 inches broad; the stem 1–2 inches long and 5–8 lines thick. The plants are found late in the season growing in thin woods either singly or in tufts. When growing in tufts the caps are often irregular from mutual pressure. From my own experience in eating this mushroom I am prepared to indorse Mr McIlvaine's words concerning it. "It is an excellent fungus, meaty, easily cooked and of fine flavor."

Hygrophorus laurae Morg.

LAURA'S HYGROPHORUS

PLATE 77, FIG. 6–14

Pileus fleshy, firm, convex becoming nearly plane or centrally depressed, sometimes umbonate, glutinous, white, usually clouded with brown, tawny brown or reddish brown in the center, flesh white; lamellae distant, decurrent, white; stem equal or tapering downward, solid, glutinous, roughened at the top

with scaly points, white or yellowish white; spores white, elliptic, .00025–.0003 of an inch long, .00016–.0002 broad.

This hygrophorus is a beautiful mushroom when fresh but its cap and gills change color in drying, by which it loses much of its beauty. Both cap and stem are smeared with a viscid substance or gluten that makes it unpleasant to handle. In the typical form the cap is white except in the center where it has a reddish or brownish tinge which sometimes spreads faintly toward the margin, but there is a variety in which the cap is entirely white or only faintly tinged with yellow. We have named this variety unicolor. Sometimes the center is slightly prominent or umbonate and the margin is irregular or wavy. The gills are decurrent and rather wide apart. They are white when fresh, but like the cap they become brown or reddish brown in drying. The stem is white or nearly so, solid, commonly tapering to a point at the base but sometimes nearly equal in all its parts. Its viscidity makes it difficult to pull the plant from its place of growth with the fingers.

The cap is 1–4 inches broad; the stem 1–4 inches long and 2–6 lines thick. This mushroom grows among fallen leaves in woods and appears during August and September. It appears to be peculiar to this country. It is related to the ivory hygrophorus and the goat moth hygrophorus of Europe but from the former it differs in its solid stem, elliptic spores and change of color in drying and from the latter by the absence of odor. I have eaten the white form only, but give a figure of the other also.

Clitopilus abortivus B. & C.

ABORTIVE CLITOPILUS

PLATE 78, FIG. 13–19

Pileus fleshy, firm, convex nearly plane or sometimes slightly depressed in the center, regular or occasionally irregular on the margin, dry, clothed at first with a minute silky tomentum, becoming smooth with age, gray or grayish brown, flesh white, taste and odor subfarinaceous; lamellae thin, close, adnate or strongly decurrent, whitish or pale gray when young, becoming salmon

colored with age; stem nearly equal, solid, minutely flocculose or fibrous striate, colored like or a little paler than the pileus; spores angular, uninucleate, salmon color, .00035–.0004 of an inch long, .00025–.0003 broad.

The abortive clitopilus takes this name because it is usually found growing with an imperfectly developed subglobose form in which there is no distinction of cap, stem or gills. It is simply an irregularly rounded mass of cellular tissue of a whitish color, originally described as a subglobose umbilicate downy mass. It is not always umbilicate nor is the surface always downy. It grows singly or in clusters of two or more.

The well developed form is generally a clean neat appearing mushroom but one of a very modest unattractive grayish colored cap and stem and with gills similarly colored when young, but becoming salmon hued when mature. The flesh is white and has a farinaceous taste and odor though the last is not always distinct unless the flesh is broken. The surface of the cap is usually coated when young by a minute silky flocculence but with advancing age this disappears or becomes scarcely visible. The gills are often very decidedly decurrent in old or fully expanded plants but only slightly so in young plants. When young they have a pale grayish color but with advancing age they assume the salmon color of the spores. They are closely placed to each other and not all of equal length. The stem is nearly equal in diameter in all its parts, solid, minutely flocculose or downy and sometimes slightly fibrous. Its color is similar to that of the cap though it is often paler.

The cap is 2–4 inches broad; stem 1.5–3 inches long and 3–6 lines thick. The species is commonly gregarious in its mode of growth, but sometimes it is single, sometimes tufted. It grows on the ground and on much decayed wood, either in woods or in open places and may be found from August to October.

When taken in good condition and properly cooked it is an excellent mushroom. If stewed gently for a short time it is less agreeable than if thoroughly cooked or fried in butter. The abortive form is also edible and is thought by some to be even better than the ordinary form.

Clitopilus micropus Pk.

SHORT STEMMED CLITOPILUS

PLATE 78, FIG. 1–12

Pileus thin, fragile, convex or centrally depressed, umbilicate, silky, gray, often with one or two narrow zones on the margin, taste and odor farinaceous; lamellae narrow, close, adnate or slightly decurrent, gray becoming salmon color with age; stem short, solid or with a slight cavity, often slightly thickened at the top, pruinose, gray, with a white mycelioid tomentum at the base; spores angular, uninucleate, salmon color, .0003–.0004 of an inch long, .00025–.0003 broad.

The short stemmed clitopilus is a small mushroom and not very plentiful and for these reasons it is not very important as an edible species, but it sometimes occurs in such abundance as to make it possible to obtain a sufficient number for the table. Its color is similar to that of the preceding species but in size it is much less. Its cap is thin and tender, broadly convex or centrally depressed. It is umbilicate and has a silky surface which is sometimes marked with one or two narrow zones near the margin. The gills are rather narrow and closely placed, broadly attached to the stem or slightly decurrent, and gray when young becoming salmon color when mature. The stem is short even when growing among fallen leaves or in grassy places, it is usually solid but in large or old specimens it is sometimes hollow. Its color is similar to that of the cap but it is slightly pruinose above and with a white tomentum at the base. In large and irregular specimens it is sometimes eccentric.

The cap is 6–16 lines broad; the stem is generally less than an inch long and is 1–2 lines thick. The mushrooms are found among fallen leaves in thin woods or in open grassy places and occur from July to September. They have a farinaceous or mealy flavor which is destroyed by cooking.

Pholiota squarrosa Mull.

SCALY PHOLIOTA

PLATE 79, FIG. 1–7

Pileus fleshy, firm, convex or nearly plane, dry, adorned with floccose tawny spreading or recurved scales, tawny, paler or yellowish on the margin, flesh whitish; lamellae thin, close, emarginate, adnexed, whitish becoming pale olivaceous, finally brownish ferruginous; stem rather long, firm, nearly equal, adorned with revolute scales, stuffed or hollow, tawny ferruginous, paler above when young, whitish above the commonly laciniate annulus; spores brownish ferruginous, elliptic, .00025–.0003 of an inch long, .00016–.0002 broad.

The scaly pholiota is not a very common mushroom but it is attractive in appearance. It is closely related to the sharp scale pholiota which it resembles in general appearance but from which it differs in its dry, not viscid, cap, in its scales which are flat instead of terete and not prominent and erect on the disk as in that species, and in its larger spores. The European plant is represented both by Schaeffer and by Bulliard as sometimes having a prominent and rather pointed elevation or umbo in the center of the cap, but I have not seen such a form here. In the American plant the young plant is almost hemispheric becoming convex or nearly plane with age. Its margin is paler than the center, fading to a yellowish color. The gills are thin and closely placed side by side. At the stem end they are more or less excavated on the edge. In the very young plant they are concealed by the veil and the incurved margin of the cap. They are then whitish but after exposure they became tinged with pale yellowish green and finally they assume a dull rusty brown hue. The stem is rather long, firm and scaly like the cap. It is stuffed or hollow, rusty tawny and furnished with an imperfect ragged collar near the top. This is at the upper termination of the scaly part and above it the stem is smooth and whitish. The cap is 2–4 inches broad; the stem is 3–5 inches long and 4–6 lines thick. The plants grow on old stumps and prostrate trunks of trees in woods, often

forming dense tufts. In such cases the caps are apt to be irregular and the stems narrower toward the base. They occur in August and September.

Hypholoma aggregatum sericeum Pk.

SILKY TUFTED HYPHOLOMA

PLATE 79, FIG. 8–14

Pileus fleshy, thin, oval when young, soon becoming campanulate or convex, silky fibrillose, white becoming grayish white with age, flesh white, taste mild; lamellae thin, close, adnate or slightly rounded behind, concealed by the veil in the young plant and then white, brown with a purplish tint when mature; stem long, flexuous, hollow, striate at the top, white; spores purplish brown, elliptic, .0003 of an inch long, .00016 broad.

The silky tufted hypholoma is so closely related to the tufted hypholoma, Hypholoma aggregatum Pk., that it is considered a mere variety of it. It differs from it in its larger size, in the entire absence of scales or spots from its cap and in the broader attachment of its gills to the stem. It is also related to the European forest hypholoma, Hypholoma silvestre Gill., from which it differs in the color of the cap and in the absence from the cap of the broad brown or blackish scales of that species. It has some points of resemblance to Candolle's hypholoma, H. candolleanum, and to the dingy white hypholoma, H. leucotephrum, but it is to be kept separate from these because it is not hygrophanous.

The cap is quite white when young, but with advancing age it assumes a more dingy or grayish hue and gradually becomes more broadly convex. Its surface is furnished with white silky fibrils which are suggestive of its varietal name. The margin is often wavy or irregular because of its crowded mode of growth and before maturity it is usually appendiculate with fragments of the veil. The flesh is white but when the cap is cut through vertically a narrow watery streak may sometimes be seen along the part next the gills. The gills are concealed at first by the copious white flocculent or webby veil. They are

then white, but after exposure they soon become brownish and finally assume the color of the spores, which is brown tinged with purple. They are not at all or only slightly rounded at the stem and the edges in the mature plant often remain white. The stems are rather long and flexuous, hollow, white, marked with short parallel longitudinal lines at the top and sometimes with reddish stains at the base.

The cap is 1.5–3.5 inches broad; the stem 3–5 inches long and 2–5 lines thick. The plants grow singly or in tufts about old stumps and appear in September. They are very good as an edible mushroom. The typical form has also been found to be edible by one of my correspondents but I have had no opportunity to try it.

Boletus bicolor Pk.

TWO COLORED BOLETUS

PLATE 81, FIG. 6–11

Pileus convex, firm, becoming softer with age, dry, glabrous or merely pruinose tomentose, dark red becoming paler and sometimes spotted or stained with yellow when old, flesh yellow, not at all or but slightly changing to blue where wounded, taste mild; tubes nearly plane in the mass, adnate, short and yellow when young, longer and ochraceous when mature, their mouths small, angular or subrotund, slowly and slightly changing to blue where wounded; stem nearly equal, firm, solid, dark red, usually yellow at the top; spores pale ochraceous brown, narrowly elliptic or subfusiform, .0004–.0005 of an inch long, .00016–.0002 broad.

The two colored boletus has the cap and stem dark red or Indian red and the tubes and flesh yellow, which is suggestive of the name applied to it. The cap becomes paler in color and softer in texture as it becomes older, and it often becomes yellowish on the margin and spotted or stained with yellow elsewhere. The surface sometimes cracks in small areas revealing the yellow flesh beneath. The tubes are at first short and bright yellow but they become longer and assume orchraceous hues as they grow older. The mouths are small and the dis-

sepiments slowly assume a blue color where wounded. The stem varies in length but it is generally nearly equal in thickness in all its parts. It is colored like the cap except at the top where it is generally yellow like the tubes. It is solid as in most boleti and by this character it may be distinguished from the closely related European Boletus barlae.

The cap is 2–4 inches broad; the stem 1–3 inches long and 4–6 lines thick. This boletus grows in thin woods or open places and seems to prefer localities where chestnut trees grow. It may be found from July to September. When properly cooked it is tender and has a fine flavor and merits a place among first class mushrooms.

Boletus pallidus Frost

PALE BOLETUS

PLATE 81, FIG. 1–5

Pileus fleshy, convex becoming nearly plane or slightly concave above by the elevation of the margin, soft, dry, glabrous, whitish, grayish or brownish, sometimes tinged with red, flesh white; tubes nearly plane in the mass when young, adnate or slightly depressed around the stem, pale yellow or whitish, usually tinged with green, becoming darker with age, their mouths small, subrotund, the dissepiments assuming bluish hues where wounded; stem commonly rather long, straight or flexuous, solid, equal or slightly thickened at the base, glabrous, whitish, sometimes streaked with brown and tinged with red within; spores pale ochraceous brown tinged with green, subfusiform, .0004–.0005 of an inch long, .0002–.00025 broad.

The pale boletus or pallid boletus is appropriately named. Its cap and stem are not a clear white but just enough shaded with brown to suggest the term pale. Whitish, dingy white, smoky white, grayish or grayish white are expressive of its varying hues. There is sometimes a slight reddish tint in the cap. Its color is apt to become darker in drying. Its surface is dry and smooth or nearly so and the cuticle is sometimes marked by fine cracks, specially on the margin. These reveal the white flesh beneath. The tubes generally form a nearly

plane surface below, but sometimes this is distinctly concave in the young plant and convex in the mature one. They are often slightly depressed around the stem and then their mouths in the depressed part are usually a little larger than elsewhere. Their color is a very pale yellow or greenish yellow and they change to bluish where wounded or bruised. The stem is generally rather long and flexuous though sometimes it is short and straight. It is solid, smooth and whitish, but sometimes streaked with brown and tinged with red within.

The cap is 2–4 inches broad; the stem 2–5 inches long and 3–8 lines thick. The plants inhabit thin woods, groves and open places, and may be found from July to September. This is an excellent boletus for the table, is easily recognized and generally free from the attacks of insect larvae. This and the preceding species, together with the red cracked boletus, B. chrysenteron, show how unreliable is the rule that directs the avoidance of all boleti whose flesh or tubes change to blue where wounded.

Boletus ornatipes Pk.

ORNATE STEMMED BOLETUS

PLATE 80, FIG. 1–5

Pileus fleshy, firm, hemispheric becoming convex or nearly plane, minutely tomentose or glabrous, gray, grayish brown or yellowish brown, flesh yellow; tubes nearly plane in the mass when young, convex when old, adnate or slightly depressed around the stem, golden yellow, their mouths small, subrotund; stem equal or nearly so, solid, firm, distinctly and beautifully reticulated, yellow without and within; spores ochraceous brown, oblong or subfusiform, .00045–.00055 of an inch long; .00016–.0002 broad.

The attractive characters of the ornate stemmed boletus and those by which it may readily be recognized are the beautifully reticulated yellow stem, yellow tubes and clean dry grayish or brownish cap. The cap is hemispheric in the young plant, broadly convex or nearly plane in the mature one. It is dry

and smooth or nearly so and variable in color. The prevailing colors are gray and brown variously blended and often intermingled with yellow. It may be brown when young fading to grayish brown or yellowish brown when mature. The flesh is yellow but this also varies in depth of hue. The tubes sometimes form a plane surface beneath the cap but sometimes those around the stem are a little shorter than the rest thereby forming a depression in the surface. They have a clear yellow color which becomes darker with age. They do not assume blue tints where bruised or wounded. The stem is usually of equal thickness throughout. It is solid and reticulated with a network of ridges from top to bottom. Its color both externally and internally is yellow.

The cap is 2–5 inches broad; the stem 2–4 inches long and 4 to 6 lines thick. This boletus grows in thin woods or in open places. It is sometimes found on earth banks by roadsides. It appears during July and August. It is clean, sound and well flavored.

Boletus eximius Pk.

SELECT BOLETUS

PLATE 80, FIG. 6–12

Pileus fleshy, very compact and globose or hemispheric when young, becoming softer and somewhat paler with age, dry, glabrous or nearly so, purplish brown or chocolate color, flesh brittle, gray or purplish gray varied with darker dots, taste mild; tubes in the young plant short stuffed or closed, concave or nearly plane in the mass, colored nearly like the pileus, becoming longer and sometimes convex in the mass when older, adnate, their mouths minute, rotund; stem equal or nearly so, sometimes slightly ventricose, solid, scurfy, colored like or a little paler than the pileus, purplish gray within; spores brownish ferruginous, oblong, .00045–.0006 of an inch long, .00016–.00025 broad.

The select boletus is a large robust species nearly of one color throughout, quite constant in its characters and easily recognized. It has a purplish brown or chocolate color which

sometimes becomes a little paler with age. The flesh has a grayish hue tinged with purple and in the cap varied with darker dots. It is very firm and brittle when young but becomes softer with age. It is so peculiar in color and so unlike any of our other species that it is easily recognized and needs no extended description.

The cap is 3–10 inches broad; the stem 2–4 inches long and 6–15 lines thick. It grows in woods or their borders and appears in July and August. It is one of the best edible species but unfortunately it is not abundant. Its large size however, may compensate to some extent for its deficiency in numbers. Sometimes a single large specimen is found growing entirely alone.

Bovista plumbea Pers.

LEAD COLORED BOVISTA

PLATE 81, FIG. 12–19

Peridium globose or nearly so, 6–14 lines in diameter, smooth, double, the exterior coat fragile, separable from the inner, breaking up and falling away at maturity, white when young, the inner thin, papery but tough, smooth, plumbeous when old, paler when first exposed, rarely becoming blackish with age, mouth apical, small; threads of the capillitium branched, free, the ultimate branches long, slender, gradually tapering to a point, purplish brown; spores brown or purplish brown, subglobose, .0002–.00025 of an inch long, nearly or quite as broad, their pedicels slender, hyaline, persistent, two to three times as long as the spores.

The lead colored bovista is a small globular puffball found growing on the ground in grassy places or in pastures. It appears both in autumn and in spring or early summer. It varies in size from half an inch to one inch in diameter. When young it is white both externally and internally, and while in this condition it is available for food. It should be discarded if the flesh has begun to lose its white color. As it approaches maturity the exterior coat is easily broken and removable in flakes or fragments. Its removal reveals the pale papery but

tough and flexible inner membrane or peridium. With advancing age this assumes a dull grayish blue or leaden hue and opens by a small aperture at the top for the escape of the spores. Any sudden pressure applied to it at this time will cause the ejection of a mass of its spores in little smokelike puffs as in other puffballs. Occasionally old specimens are found in which the inner peridium is almost black. The small size, peculiar color and distinctly double coat of the immature plant are characters which make this bovista easily recognizable. Its flavor is much more agreeable than that of many of the small species of the genus Lycoperdon.

EXPLANATION OF PLATES

PLATE K

Clitocybe regularis Pk.

REGULAR CLITOCYBE

FIG.

1 Immature plant
2 Mature plant with convex cap
3 Mature plant with nearly plane cap
4 Vertical section of an immature plant
5 Vertical section of the upper part of a mature plant
6 Transverse section of a stem of a mature plant
7 Four spores × 400

Clitocybe subconcava Pk.

SUBCONCAVE CLITOCYBE

8 Plant with the cap moist
9, 10 Two plants with caps dry
11 Vertical section of the upper part of a plant
12 Transverse section of a stem
13 Four spores × 400

Hydnum umbilicatum Pk.

UMBILICATE HYDNUM

14 Immature plant showing the upper surface of the cap
15, 16 Two mature plants showing both surfaces of the cap
17 Vertical section of the upper part of a plant
18 Four spores × 400

Boletus multipunctus Pk.

FIG. MANY DOTTED BOLETUS

19 Plant with a convex cap
20 Plant with the cap nearly plane
21 Vertical section of the upper part of a plant
22 Four spores × 400

PLATE L

Cortinarius obliquus Pk.

OBLIQUE BULBED CORTINARIUS

1 Immature plant
2 Mature plant
3 Vertical section of the upper part of an immature plant
4 Vertical section of the upper part of a mature plant
5 Four spores × 400

Cortinarius submarginalis Pk.

SUBMARGINED CORTINARIUS

6 Immature plant
7 Mature plant
8 Vertical section of the upper part of an immature plant
9 Vertical section of the upper part of a mature plant
10 Four spores × 400

Helvella adhaerens Pk.

ADHERING MARGINED HELVELLA

11 Small pale plant
12 Large plant of darker color
13 Vertical section of a plant
14 A paraphysis and an ascus containing spores × 400
15 Four spores × 400

PLATE 77

Tricholoma russula (Schaeff.) Fr.

REDDISH TRICHOLOMA

1 Immature plant
2 Mature plant with convex cap
3 Mature plant with cap nearly plane
4 Vertical section of the upper part of a plant
5 Four spores × 400

Hygrophorus laurae Morg.

LAURA'S HYGROPHORUS

FIG.

6 Immature plant

7 Mature plant with umbonate cap

8 Mature plant with cap nearly plane

9 Plant showing the colors assumed in drying

10 Vertical section of the upper part of an immature plant

11 Vertical section of the upper part of a mature plant

12 Four spores × 400

var. **unicolor**

13 Immature plant

14 Mature plant

PLATE 78

Clitopilus micropus Pk.

SHORT STEMMED CLITOPILUS

1 Immature plant

2 Immature plant with the margin of the cap slightly zoned

3-6 Mature plants with caps differing in form

7 Mature plant with lobed cap and eccentric stem

8 Vertical section of the upper part of an immature plant

9 Vertical section of the upper part of a mature plant with solid stem

10 Vertical section of the upper part of a mature plant with hollow stem

11 Transverse section of a hollow stem

12 Four spores × 400

Clitopilus abortivus B. & C.

ABORTIVE CLITOPILUS

13 Immature plant

14 Mature plant with convex cap

15 Mature plant with the cap centrally depressed

16 Vertical section of the upper part of an immature plant

17 Vertical section of the upper part of a mature plant

18 Four spores × 400

19 Two abortive plants

PLATE 79

Pholiota squarrosa Mull.

SCALY PHOLIOTA

FIG.

1 Cluster of three young plants
2 Immature plant
3 Mature plant
4 Vertical section of the upper part of an immature plant
5 Vertical section of the upper part of a mature plant
6 Transverse section of a stem
7 Four spores × 400

Hypholoma aggregatum sericeum Pk.

SILKY HYPHOLOMA

8 Cluster of four young plants
9 Immature plant
10 Mature plant
11 Vertical section of the upper part of an immature plant
12 Vertical section of the upper part of a mature plant
13 Transverse section of a stem
14 Four spores × 400

PLATE 80

Boletus ornatipes Pk.

ORNATE STEMMED BOLETUS

1 Immature plant
2 Mature plant with convex cap
3 Mature plant with cap more expanded
4 Vertical section of the upper part of a plant
5 Four spores × 400

Boletus eximius Pk.

SELECT BOLETUS

6 Immature plant
7 Mature plant with convex cap
8 Mature plant with cap more expanded
9 Mature plant of larger size
10 Vertical section of the upper part of an immature plant
11 Vertical section of the upper part of a mature plant
12 Four spores × 400

PLATE 81

Boletus pallidus Frost

PALE BOLETUS

FIG.

1 Immature plant

2 Mature plant with convex cap

3 Mature plant with cap more expanded

4 Vertical section of the upper part of a plant

5 Four spores × 400

Boletus bicolor Pk.

TWO COLORED BOLETUS

6 Young plant

7 Immature plant

8 Mature plant

9 Vertical section of the upper part of an immature plant

10 Vertical section of the upper part of a mature plant

11 Four spores × 400

Bovista plumbea Pers.

LEAD COLORED BOVISTA

12, 13 Immature plants differing in size

14 Plant nearly mature showing inner coat in three places

15 Mature plant with part of outer coat remaining at the base

16 Mature plant with outer coat wholly gone

17 Small mature plant with inner coat nearly black

18 Part of a branching thread of the capillitium × 400

19 Four spores and their pedicels × 400

FUNGI.

JAMES B. LYON, STATE PRINTER.

FIG. 1-7 **CLITOCYBE REGULARIS** PK.
REGULAR CLITOCYBE

FIG. 8-13 **CLITOCYBE SUBCONCAVA** PK.
SUBCONCAVE CLITOCYBE

FIG. 14-18 **HYDNUM UMBILICATUM** PK.
UMBILICATE HYDNUM

FIG. 19-22 **BOLETUS MULTIPUNCTUS** PK.
MANY DOTTED BOLETUS

FUNGI.

JAMES B. LYON, STATE PRINTER.

Fig. 1-5 **CORTINARIUS OBLIQUUS** Pk.
OBLIQUE BULBED CORTINARIUS

Fig. 6-10 **CORTINARIUS SUBMAGINALIS** Pk,
SUBMARGINED CORTINARIUS

Fig. 11-15 **HELVELLA ADHAERENS** Pk.
ADHERING MARGINED HELVELLA

EDIBLE FUNGI.

Fig. 1-12 **CLITOPILUS MICROPUS** Pk.
SHORT STEMMED CLITOPILUS

Fig. 13-19 **CLITOPILUS ABORTIVUS** B. & C.
ABORTIVE CLITOPILUS

EDIBLE FUNGI.

JAMES B. LYON, STATE PRINTER.

Fig. 1-7 **PHOLIOTA SQUARROSA** Mull.
SCALY PHOLIOTA

Fig. 8-14 **HYPHOLOMA AGGREGATUM SERICEUM** Pk.
SILKY HYPHOLOMA

EDIBLE FUNGI.

JAMES B. LYON, STATE PRINTER.

Fig. 1-5 **BOLETUS ORNATIPES** Pk.
ORNATE STEMMED BOLETUS

Fig. 6-12 **BOLETUS EXIMIUS** Pk.,
SELECT BOLETUS

EDIBLE FUNGI.

C. H. Peck, del.

JAMES B. LYON, STATE PRINTER.

Fig. 1-5 **BOLETUS PALLIDUS** Frost
PALE BOLETUS

Fig. 6-11 **BOLETUS BICOLOR** Pk.
TWO COLORED BOLETUS

Fig. 12-19 **BOVISTA PLUMBEA** Pers.
LEAD COLORED BOVISTA

INDEX

The superior figures tell the exact place on the page in ninths; e. g. 961^{3} means page 961 beginning in the third ninth of the page, i. e. about one third of the way down.

For full indexes to museum bulletins, see index printed with each bulletin.

For full indexes to museum bulletins, see *index printed with each bulletin.*

For full indexes to museum bulletins, see index printed with each bulletin.

For full indexes to museum bulletins, see index printed with each bulletin.

Q
11
N8
1901

New York. State Museum, Albany

Report